Twenty-second Annual Report

of the

NEW JERSEY STATE

Agricultural Experiment Station

and the

FOURTEENTH ANNUAL REPORT

of the

New Jersey Agricultural College Experiment Station

for the year ending

October 31st, 1901.

TRENTON, N. J.:
The John L. Murphy Publishing Co., Printers.
1902.

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To His Excellency Foster M. Voorhees, LL.D., Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the twenty-second annual report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10th, 1880, and which is chapter CVI. of the laws of that year.

DAVID D. DENISE,
President.

NEW BRUNSWICK, N. J., November 30th, 1901.

To His Excellency Foster M. Voorhees, LL.D., Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2d, 1887, and with an act of the Legislature of this State, approved March 5th, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey maintaining Rutgers Scientific School, the New Jersey State College for the benefit of Agriculture and Mechanic Arts, the fourteenth annual report of the operations of that department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

AUSTIN SCOTT,
President.

NEW BRUNSWICK, N. J., November 30th, 1901.

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS,

NEW BRUNSWICK, N. J.

1. STATE STATION. ESTABLISHED 1880.

BOARD OF MANAGERS.

HIS EXCELLENCY FOSTER M. VOORHEES, LL.D., Trenton, Governor of the State of New Jersey.
AUSTIN SCOTT, PH.D., LL.D., . . New Brunswick, President of the State Agricultural College.
EDWARD B. VOORHEES, Sc.D., . Professor of Agriculture of the State Agricultural College.

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EPHRAIM T. GILL, . . . Haddonfield.
ROBERT GWYNNE, . . Salem.

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WINFIELD S. BONHAM, . . Shiloh.
JOHN E. DARNELL, . . Masonville.

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JOSIAH KETCHAM, . . . Belvidere.
JAMES A. BURNETT, . . . Hilton.

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ABRAM C. HOLDRUM, . . Westwood.
GEORGE H. BLAKELEY, . Paterson.

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GEORGE E. DE CAMP, . . . Roseland.
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LUCIUS F. DONOHOE, M.D., . Bayonne.

TENTH CONGRESSIONAL DISTRICT.

JOHN B. WILLIAMS, . . . New Durham.
PHILIP M. BRETT, . . . Jersey City.

STAFF.

EDWARD B. VOORHEES, Sc.D., ... Director.
IRVING S. UPSON, A.M., ... Chief Clerk; Secretary and Treasurer.
LOUIS A. VOORHEES, A.M., ... Chief Chemist.
JOHN P. STREET, M.Sc., ... Associate Chemist.
ALVA T. JORDAN, B.Sc., ... Assistant in Horticulture.
CLARENCE B. LANE, B.Sc., ... Assistant in Dairy Husbandry.
JACOB G. LIPMAN, A.M., ... Soil Chemist and Bacteriologist.
WILLIAM P. ALLEN, B.Sc., ... Assistant Chemist
MARY A. WHITAKER, ... Stenographer and Typewriter.
VINCENT J. CARBERRY, ... Laboratory Assistant.
HARRY W. WILLIAMS, ... Janitor.

2. AGRICULTURAL COLLEGE STATION. ESTABLISHED 1888.

BOARD OF CONTROL.

The Board of Trustees of Rutgers College in New Jersey.

EXECUTIVE COMMITTEE OF THE BOARD.

AUSTIN SCOTT, PH.D, LL.D., President of Rutgers College, Chairman, . . New Brunswick.
HON. HENRY W. BOOKSTAVER, LL.D., ... 24 East 64th Street, New York City.
HENRY R. BALDWIN, M.D., LL.D., ... New Brunswick.
JAMES NEILSON, ... New Brunswick.
PAUL COOK, ... Troy, New York.
WILLIAM H. LEUPP., ... New Brunswick.

STAFF.

EDWARD B. VOORHEES, Sc.D., ... Director.
JULIUS NELSON, PH.D., ... Biologist.
BYRON D. HALSTED Sc.D., ... Botanist and Horticulturist.
JOHN B. SMITH, Sc.D., ... Entomologist.
JAMES A. KELSEY, M.Sc., ... Field Assistant.
IRVING S. UPSON, A.M., ... Disbursing Clerk and Librarian.
AUGUSTA E. MESKE, ... Stenographer and Typewriter.

THE COLLEGE FARM.

The Trustees of the College give the Stations the use of seven acres of land for experiments in Horticulture and Botany, and the remainder of the farm (90 acres), well stocked and equipped, for experiments in Dairying. The income from the dairy pays for the labor and maintenance of the farm, and in part for dairy experiments.

TREASURER'S REPORT.

Irving S. Upson, in account with the New Jersey State Agricultural Experiment Station, November 1st, 1900, to October 31st, 1901.

APPROPRIATION FOR SALARIES AND EXPENSES.

RECEIPTS.

From State Treasurer	$15,000 00

PAYMENTS.

Salaries and pay of chemists and assistants	$9,601 26
Expenses of the Board of Managers	61 86
Stationery	122 61
Printing	272 82
Postage	195 45
Furniture	48 35
Fuel	445 34
Gas, electricity and water	237 78
Laboratory expenses	254 04
Field and feeding experiment expenses	1,665 30
Freight, express and cartage	131 61
Expenses collecting samples of fertilizers	521 58
Traveling expenses	194 30
General fittings, repairs and improvements	1,073 72
Insurance	54 09
Reference books	107 24
Contingent expenses	12 65
	$15,000 00

APPROPRIATION FOR CARRYING OUT THE PROVISIONS OF "AN ACT CONCERNING THE REGULATION OF THE SALE OF CONCENTRATED COMMERCIAL FEEDING STUFFS."

RECEIPTS.

From State Treasurer	$3,000 00

PAYMENTS.

Salaries and pay of chemists and assistants	$1,617 33
Stationery	116 18
Printing	481 08
Postage	21 80
Laboratory fittings, apparatus and supplies	547 64
Expenses collecting samples of feeding stuffs	202 94
Reference books	13 03
	$3,000 00

APPROPRIATION FOR PRINTING BULLETINS.

RECEIPTS.

From State Treasurer	$1,000 00

PAYMENTS.

For printing bulletins	$1,000 00

Respectfully submitted,

IRVING S. UPSON,
Treasurer.

The Auditing Committee of the Experiment Station have examined the accounts of the Treasurer of said Station, and have found them correct.

JOHN E. DARNELL,
GEORGE E. DE CAMP,
Auditing Committee.

NEW BRUNSWICK, N. J., January 11th, 1902.

FINANCIAL STATEMENT.

THE TRUSTEES OF RUTGERS COLLEGE

FOR

THE NEW JERSEY STATE AGRICULTURAL COLLEGE EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1900-1901.

		Dr.
To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1901, as per act of Congress approved March 2d, 1887		$15,000 00
By Salaries	$9,460 00	
Labor	1,146 52	
Publications	1,176 41	
Postage and stationery	212 48	
Freight and express	70 77	
Heat, light and water	309 94	
Chemical supplies	83 39	
Seeds, plants and sundry supplies	125 64	
Fertilizers	65 90	
Feeding stuffs	267 01	
Library	660 16	
Tools, implements and machinery	7 75	
Furniture and fixtures	14 97	
Scientific apparatus	426 62	
Live stock	35 00	
Traveling expenses	313 19	
Contingent expenses	166 77	
Building and repairs	457 48	
Total		$15,000 00

We, the undersigned duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ending June 30th, 1901, that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving no unexpended balance.

And we further certify that the expenditures have been solely for the purpose set forth in the act of Congress approved March 2d, 1887.

Signed, AUSTIN SCOTT,
EDWARD B. VOORHEES,
Auditors.

REPORT OF THE DIRECTOR.

REPORT OF THE DIRECTOR.

The work of the Stations (State and College) the past year has been enlarged mainly in two directions. First, the required inspection and analysis of commercial feeds; and second, the scientific study of oyster propagation. The chemical work has also been reorganized, and a laboratory provided for the chemical and bacteriological study of soils. The work that is regarded as of more direct and immediate use to farmers has not been reduced by virtue of the larger field of scientific investigation, and the continued appreciation by the public of the results obtained by the Stations, is shown both in the constantly increasing demand for their publications and for direct information as to specific needs.

The Analyses of Commercial Fertilizers.

The inspection this year has required the analyses of 314 samples of different brands of complete fertilizer, 25 of ground bone, and 37 of miscellaneous products. There has been one case of direct adulteration discovered, and many, as in the past, where at the prices charged per ton, plant-food is furnished at an exorbitant cost, though the manufacturers have adhered closely to their guarantee. In other words, a careless purchase may result in what is virtually as bad as direct fraud. A study of the work of the year also shows a tendency on the part of consumers to purchase in special lots or special brands made to their order, rather than regular brands, which accounts in part for the larger number examined. Owing to a decision on the part of the company which controls a number of the plants for the manufacture of fertilizers, to withhold statistics as to sales, no definite information is obtainable as to the growth of the industry the past year, though the wide distribution of brands would seem to indicate that there has been no decrease in consumption, but rather a considerable increase. In many sections of the State, farmers' clubs and other organizations, as a direct result of the Station's sug-

gestions, are purchasing their goods either in the form of raw materials or as manufactured brands made directly for their use. In one or two instances, 600 tons or more are purchased in one order, though the amounts range from a carload up. In the purchase of brands made according to a formula furnished to the manufacturer, agents' prices are usually obtained, hence the saving ranges from $5 to $8 per ton, or an average of 25 per cent., while in the purchase of raw materials the saving in the cost of plant-food is often still greater. The business-like manufacturers are eager for this trade, as payments are usually made partly cash on delivery, and the remainder on short time, a saving to them of both capital and agents' expenses. Wherever this system of purchase is practiced, it is the experience of farmers that the goods give quite as satisfactory results as do the regular brands put up by the manufacturers. In other words, the reduction in cost is not accompanied by a reduction in quality of plant-food. The average of all of the manufactured brands purchased in the regular way shows that the cost of plant-food is less than in 1900, or, in other words, that the charges for mixing, bagging and handling are lower.

The tables of analyses also show 59 samples of standard products, 18 special mixtures and 8 home mixtures. A reduction in the number of samples over those found in many previous years, and due largely to the tendency already pointed out of farmers purchasing goods made according to their formulas and from materials which they have selected. It is an illustration of the better knowledge on the part of the farmers in reference to what constitutes a fertilizer, and that other things being equal, the price per pound of the constituent is a safe guide in such purchase. The investigations which have been conducted by the Station for years on the economy in the purchase and use of fertilizing materials, have resulted in recommendations to purchase the raw materials and mix for themselves, rather than pay the charges made for mixing, handling and selling, have been largely responsible for the change from that method to the present one, now more largely used. Farmers in certain localities have begun, first, with a small purchase and use of raw materials, have determined the effectiveness and profitableness of such purchase and use, and the knowledge thus gained has had a tendency both to increase the use of plant-food from year to year and to enable the purchase of the mixed materials in an intelligent and business-like way. They know how to purchase their materials at quite as low a price per pound without the intervening trouble of preparing

and mixing their own mixtures. There is one point, however, which the Station is obliged to insist upon, and that is, that individual farmers or clubs in purchasing goods should confine themselves to fewer brands, that is, to use one for various crops, provided they desire to have their individual purchases analysed. The Station has offered to make analyses in cases where 20 tons or more are purchased, for unless as large a quantity as this is represented, the work of the Station becomes in part, at least, an individual rather than a public matter, and the Station cannot under any circumstances make analyses, the results of which may be regarded as of a private nature.

The very large amount of work involved in the inspection and analyses of fertilizers in recent years, has been made possible because of improvements in the methods of analyses, which has materially shortened the time required for many determinations. This work is of the highest importance, and the chemists devote much time to such study—the results are rather reported to the Association of Official Agricultural Chemists than published in full as a part of the work of the Station.

This year much time has been devoted to the collating and study of methods for the analysis of insecticides, and to the investigation of methods devised for determining the quality of the organic nitrogen as it exists in the regular brands of fertilizers. This latter investigation is of primary importance, and so much has been accomplished as to lead to the hope that a practicable method may soon be devised and adopted.

The Analyses of Commercial Feeds.

Chapter 29 of the Laws of 1900 invested the Experiment Station with the inspection of commercial feeds. The importance of a law of this kind has been previously pointed out, and the results obtained from the inspection of last year abundantly verify the arguments made in its favor. Bulletin No. 153, issued as a result of the first inspection and analysis, shows that a wide variation exists in the composition of feeds upon the market offered under the same general name, and that there is a very great need of the knowledge of the composition of these special brands, as well as of those of a more concentrated character, in order to enable an intelligent purchase. This bulletin gives this information, together with suggestions as to the kind and character of the supplies needed under average conditions, besides it contains the analyses of 469 samples, representing 65 different kinds of feed, and though these may be classified in four

groups, wide variations exist in the analyses of the samples of each group. The bulletin was prepared with great care, and the various points of interest discussed in much detail, and information given which is of value to the producer, the purchaser and the general reader. The principles underlying the selection of feeds are clearly pointed out, and the necessity for a careful comparison of the different products offered strongly urged, as well as that the purchaser should clearly discern between commercial and nutritive values. It is gratifying to note, that even in this first year of the operation of the law, that the leading manufacturers and dealers are thoroughly in accord with the provisions of the law, and are not only willing to comply, but stand ready to assist in every way possible, knowing that their interest lies, as does that of the fertilizer manufacturer, in the education of the farmer in reference to true values. Progressive work of this character is of great usefulness, and owing to the present organization of the Station, it is obtained for the public at a very small cost to the State.

In addition to the analyses of commerical feeds, a number of samples of forage and farm crops, grown for the purpose of studying their adaptability and usefulness, have been examined and tabulated in the body of the report, together with a table showing the average composition of the feeds, fodders and forage crops grown and sold in the State.

Plant Nutrition.

These studies begun in 1898, have been carried on with every scientific precaution, and results of far-reaching importance have already been obtained. The data obtained and a discussion of the purely scientific phases of the work have been published from year to year. The practical value of an application of results secured seemed, however, to be of such immediate importance to the farmers, particularly in the handling and use of home manures, that a study of all of the data bearing upon this point was made and the results published in Bulletin No. 150, entitled "I. Losses in Farm Manures. II. The Relative Usefulness of the Nitrogen in Fresh and in Leached Manures. III. The Comparative Value of the Nitrogen in Commerical Forms and in Natural Manures." The results obtained this year, though not yet fully tabulated, are striking and confirm in a remarkable manner, with wheat and rye, those obtained with oats and corn. One branch of this investigation has for its object to determine whether denitrification (the setting free of combined

nitrogen) occurs in the combined use of nitrates and organic nitrogenous materials; thus far the results do not show marked losses in this direction, and in order that the whole matter may be on record, a historical sketch, showing the growth and development of this line of investigation and results obtained, together with a bibliography have been incorporated in this report.

In addition to the more scientific phase of the subject, field experiments with eleven of the leading market garden crops of the State were carried out to study the practical side of the question of nitrogen asssmilation and results were obtained of great practical value, though they are not ready for incorporation in this report.

HORTICULTURE.

In this department the field work has been very materially increased owing to the fact that most of the varieties fruited this year, though the season was not as favorable for large crops as in 1900.

The very great usefulness of experiments which show the advantage of a careful selection of varieties is apparent in the results secured again this year. For example, in a comparison of the value of the crops of all of the known varieties of aspargus, it is shown that the value per acre of the best variety is $284 greater than that of the poorest variety under identical conditions of soil and treatment. The same is true in regard to blackberries—gains of over 100 per cent. in the value of crops are shown to exist between the best and the poorest variety, while in the case of raspberries, currants and strawberries, the gain is even greater. In the case of tree fruits, an insufficient number of crops have been received to enable a strict comparison of the value of different varieties or methods of treatment.

The results of the study of methods of fertilizing and manuring are also very important and show very positively that for asparagus particularly, commerical fertilizers may be used to substitute yard manures, the yields obtained are greater and the cost of material and labor less.

The experiments on the irrigation of asparagus and small fruits have been continued, and in the case of blackberries, gooseberries, raspberries and currants, the advantage of the added water is very noticeable. These studies in connection with those in other parts of the State with small irrigation plants in co-operation with the United

States Department of Agriculture, have given results of much value concerning the practicability of irrigation in the humid districts.

Studies in the forcing-house have been continued, mainly with cauliflower, lettuce, tomatoes and cucumbers, both as to the varieties of the plants best adapted for the purpose, as well as concerning methods of treatment and feeding.

DAIRY HUSBANDRY.

In this department the investigations have been continued mainly along the line of the adaptability and usefulness of varieties of forage crops, as well as concerning the establishment of forage crop rotations. All of the leading varieties of plants generally used or recommended for this purpose have been studied, and in many cases the rotation has been such as to enable the growing of three different crops per acre per year, with a yield in some cases exceeding 25 tons. The experiments have also been continued with protein crops, as cow peas, oats and peas, and alfalfa, for the purpose of determining their usefulness as substitutes for expensive concentrated protein feeds. The very great increase in price of feeds in the past year renders this line of experimentation particularly usefnl.

The experiments with alfalfa have been continued and large yields have been obtained. Field experiments in growing alfalfa, and feeding experiments to determine whether alfalfa protein might substitute the protein of wheat bran and dried brewers' grains were carried out, and the results reported in Bulletin No. 148 showed the great value of this plant, where it can be successfully grown, and that its use as hay reduced the necessity for the purchase of protein feeds. Many experiments were carried out this year to determine the adaptability and usefulness of this plant in the various sections of the State; the season was, however, unusually unfavorable in many respects for the success of these experiments—the heavy rains stimulating a very rapid growth of weeds and the scalding of the young alfalfa plants.

The investigations concerning the composition of milk of dairy herds have been continued, and the data obtained fully confirm the conclusions already reached, that it is possible to control, within reasonable limits, the composition of milk, and thus to guarantee a uniform product to the consumer. The study of the economics of the retail dairy business has also been continued.

An addition to the barn at the College Farm was built through the generosity of the Trustees, and in its erection an attempt was made

to have incorporated such features as are now believed to be essential in the housing of dairy stock for the purpose of producing sanitary milk. A full description and outline plans are contained in the main body of the report. A small silo has also been erected by the Station to study the question of the comparative value of soiling and of summer silage; this has been partly filled with corn and cow peas for future feeding experiments. This is a distinct and important addition to the working equipment of the Station. The farm, aside from its usefulness in providing for the carrying out of experiments, is a valuable adjunct to the Station in furnishing an object-lesson in modern methods of farm management. The increased number of visitors from all parts of the State express themselves as much benefited by what they see and hear. The application of the principles of scientific farming are apparent here, and the results are uniformly in favor of the adoption of the practice recommended, *i. e.*, that the proper handling and use of farm manures, the growing of green manure crops, the use of good seed, and the application of business principles to all the details of the work result in making farming profitable. For the year ending April 1st, 1901, there was produced an average of 8.1 tons of forage for each acre under cultivation.

BIOLOGY.

In the Biological Department the work has followed the same lines as last year, viz. : Bovine tuberculosis, dairy bacteriology and oyster culture.

Under the first head, an extended series of observations of cows' temperatures has been taken, with unusual care, to ascertain as accurately as possible the relative effect of external conditions—particularly air temperature fluctuations—upon the "temperature curve" of cattle. These data are published in the present report.

Under the second head, the Bulletin No. 152, "Domestic Pasteurizing Methods and the Care of Milk in the Home," was issued early in the summer. This is a popular exposition of the results of the experiments and household experience of the biologist in caring for milk during hot weather, and includes a description of the methods of using milk in infant feeding.

The principal line of work of the biologist has been the subject of "scientific oyster propagation," a special act having been passed by the last Legislature, making a small appropriation for "establish-

ing and maintaining" one or more oyster experiment stations, under the direction of the Agricultural College Experiment Station.

Such a station was established, and maintained near Tuckerton, during the oyster-breeding season, from June 20th to August 30th. Careful studies have been made of the eggs of oysters, which are so small that they are individually about invisible to the naked eye. Oysters have been raised from the "spat stage" to the "seed stage" in tanks and other artificial surroundings, showing that the conditions in such environments were favorable to life and growth.

As a result of the season's work, the biologist is convinced of the erroneousness of the current beliefs, that if artificially propagated oyster spawn were given the proper food and environment, it will live and mature; and that if we only knew how to properly care for such spawn, the problem of artificial oyster propagation would have been solved.

The real trouble, however, seems to be that we do not yet know how to select eggs of the proper ripeness and vigor, nor how to fertilize them with the best sperms. Therefore, the investigations were mainly directed towards the careful study of oyster eggs, and the results are illustrated by means of several plates accompanying this report.

BOTANY.

The work in the Botanical Department for the year has been largely upon the Experiment Area at the College Farm, supplemented with laboratory study, and investigations in various parts of the State.

Attention has been given to the breeding of sweet corn, beans, lima beans, tomatoes, egg-plants, cucumbers, salsify, squashes, etc. The hope of combining a white and black sort of sweet corn so as to produce a new pink variety is beginning to be realized in that several ears with all the grains of the desired color have been obtained the present season. Out of the same line of work, by careful selection, it is hoped to obtain a variety with unusual productiveness.

The combination of two standard sorts of bush lima beans has been effected, and the cross shows a union of the good qualities of the parents. It still remains to fix the characteristics in this new variety when it will be ready for distribution.

The same is true of the new egg-plant that is superior to both the parents, and with an acceptable shape, high quality and productive, vigorous plants, it may prove a valuable acquisition to our truck

farmers. There is a demand for the seed, but it is withheld, as more time is required to fix the strain.

Some superior forms of cucumbers have come from breeding, and it is hoped that shortly the Station will have something in this line to offer its constituents.

The end in view in the crossing of tomatoes, namely, a more upright and vigorous plant with the amount of seed in the fruit greatly reduced, is being approached, and tomatoes absolutely seedless have been obtained. The work of fixing the desired qualities here may require more time than with the other kinds of plants above named.

A hybrid between two species of salsify has shown remarkable variations in some directions, but sufficient time has not elapsed for a test of the quality of the roots.

In connection with the above tests in breeding some interesting facts have become evident that will help in future work along the same lines.

Some time has been given to the study of such weeds as broomrape and dodder, and the latter is a subject for study in the greenhouse. Tests have also been made under glass to determine the effect of conditions upon sex and sex organs in plants. For this flax and buckwheat have been employed. Albinism in sweet corn was under examination through the winter, and it was found not to be due to any condition of germination, but is in the seed itself and perhaps the result of some enfeebled growth. Some spraying experiments in the greenhouse point to kerosene emulsion as a suitable remedy for the powdery mildew of hot-house roses and many other plants grown under glass. This line of study is to be hopefully continued.

Many plants have been determined from week to week, and occasional samples of suspected commercial seeds examined for weed seeds.

One bulletin has been issued since the last annual report, namely, No. 151, "Bean Diseases and Their Remedies," with four plates, nine figures and twenty-eight pages.

ENTOMOLOGY.

In the department of insects one of the main lines of investigation has been a study of the mosquito problem as it exists in the State at the present time. The subject is too large for any one person to cover in any one year, and all that was attempted was to ascertain, *first*, the distribution of the species responsible for the spread of malarial diseases; *second*, the determination of the most common species and their distribution in the State; *third*, the general methods that might be employed to check or control the insects; and *fourth*, the part that the individual, municipality and State respectively should assume in the effort to effect a permanent mitigation of a pest which, directly and indirectly, causes a loss of many thousands of dollars annually to our citizens and lessens enormously the value of much of the coast and other lands of the State. The investigation has reached a point where it requires material assistance to complete the work and promises results that will do away with from 75 per cent. to 90 per cent. of the troublesome forms in the State.

The life history of the katydid that annually destroys thousands of bushels of cranberries has been completed and the egg-laying habits have been ascertained. It will now be possible for the growers to control the insect and practically avoid injury by simple and inexpensive methods.

Studies on scale insects have been continued and the life history of the form that has of late years injured blackberry and raspberry canes has been completed.

Work in the Experiment Orchard has been continued and a number of insecticides have been tested to ascertain their range of usefulness against insects and their effects on plant-life.

The work done with crude petroleum to check the spread and injury done by the San José or pernicious scale has been followed and the experience gained will be incorporated in the annual report.

An interesting line of work was the introduction into the State of a Chinese species of *Mantid*, a predatory insect which, it is hoped, will prove useful in checking the spread of certain injurious forms. It appears now that the work will prove successful so far as the introduction of the insect is concerned; whether it will prove as beneficial as is hoped, remains to be seen.

A number of less important investigations were carried on as the character of the complaints received during the season made it necessary. In all respects the season has been busy as well as profitable.

Two bulletins were issued from the Department since the last report: No. 147, dealing with the "Angoumois Grain Moth," and No. 149, dealing with "Two Strawberry Pests."

As in the past, the Station officers have kept in close contact with the farmers throughout the State, by attending the various meetings of the county boards of agriculture, of farmers' institutes, by the issuing of special information bulletins on various subjects, and by direct correspondence with the farmers. The Station, in addition to its function as an institution for scientific investigation, is a bureau of information on all subjects relating to the farm.

During the year many additions of valuable books of reference have been made to the library, besides the binding of reports and bulletins of other Stations; it is also well supplied with all of the leading journals, bearing upon the various lines of scientific work connected with the institution, together with the leading agricultural and stock papers.

The equipment of the various departments has also been materially enlarged, particularly in the chemical and biological departments, and the working facilities of all well kept up.

REPORT OF THE CHEMISTS.

REPORT OF THE CHEMISTS.

FERTILIZERS.

I.

THE MARKET PRICES OF FERTILIZERS.

For a number of years past, this Station has published a record of the annual sales of fertilizers in the State. Each year of late the manufacturers have shown more reticence about supplying the data covering their output, and for this reason it is thought best this year to omit the statistical part of this report.

The records of preceding years have shown that the farmers of this State have paid on an average about $1,200,000 annually for complete fertilizers. It is, therefore, a matter of importance to ascertain the principal conditions which influence the selling price of these materials.

Complete fertilizers are made by mixing a number of crude products or raw materials, each of which contains one or more of the following elements of plant-food, viz., nitrogen, phosphoric acid and potash. Efforts have been made, therefore, to secure—

The average wholesale prices of nitrogen, phosphoric acid and potash.
The average retail prices of nitrogen, phosphoric acid and potash.
The advance in prices between the wholesale and retail markets.

The wholesale prices of crude products, or raw materials, are quoted every Monday in the well-known trade journal, *The Oil, Paint and Drug Reporter.* These prices have been tabulated for the entire year, and have then been recalculated upon the basis of the following analyses, in order to express the results as prices of actual plant-food, which is the form adopted by the Experiment Stations of this country.

Nitrate of Soda	16	per cent.	Nitrogen.
Sulfate of Ammonia	20½	"	"
Dried Blood	12½	"	"
Acid Phosphate	12	"	Available Phosphoric Acid.
High-Grade Sulfate of Potash	50	"	Potash.
Double Sulfate of Potash and Magnesia	25	"	"
Muriate of Potash	50	"	"
Kainit	12½	"	"

The retail prices were calculated from the analyses of those samples of raw materials published in the report of 1900, which were taken from goods in the hands of farmers and which had been bought for cash direct from the manufacturers of complete fertilizers.

The price of nitrate of soda showed a considerable fluctuation, particularly from March 1st to July 1st, varying from 10.4 to 13.7 cents per pound. The average price, 11.6 cents, is much higher than that of last year, and higher than any year since 1894. Sulfate of ammonia has been quite constant in price during the year, being slightly lower than in 1899. Dried blood has shown the greatest increase in price of any of the raw materials, reaching as high as 15.5 cents in February, with an average for the year of 14 cents. Acid phosphate and the potash salts showed little fluctuation during the year, and the average prices differ little from those of previous years.

Wholesale Prices in New York, per Pound, of Plant Food.

MONTHS.	Wholesale cost of nitrogen in form of— Nitrate of soda. Max.	Nitrate of soda. Min.	Sulfate of ammonia. Max.	Sulfate of ammonia. Min.	Dried blood. Max.	Dried blood. Min.	Wholesale cost of phosphoric acid in form of— Acid phosphate. Max.	Acid phosphate. Min.	Wholesale cost of potash in form of— Kainit. Max.	Kainit. Min.	Muriate of potash. Max.	Muriate of potash. Min.	Double sulfate of potash and magnesia. Max.	Double sulfate of potash and magnesia. Min.	High-grade sulfate of potash. Max.	High-grade sulfate of potash. Min.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
January	11.8	11.5	14.6	14.4	13.6	13.3	3.1	3.0	4.1	3.5	3.7	3.6	4.2	4.1	4.1	4.0
February	12.5	12.1	14.9	14.6	15.5	15.1	3.1	3.0	3.9	3.5	3.7	3.6	4.2	4.1	4.1	4.0
March	13.7	13.1	15.2	15.1	15.2	15.1	3.3	3.1	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
April	13.3	12.8	14.9	14.6	15.2	14.9	3.3	3.1	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
May	11.3	11.1	14.3	14.1	14.1	13.8	3.3	3.1	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
June	10.5	10.4	14.1	13.9	13.0	12.5	3.3	3.1	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
July	10.9	10.8	13.8	13.6	12.9	12.4	3.3	3.1	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
August	11.2	10.9	14.0	13.9	13.8	13.7	3.4	3.3	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
September	11.2	11.0	13.7	13.6	13.6	13.6	3.4	3.3	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
October	11.3	11.1	13.8	13.6	14.1	14.1	3.4	3.3	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
November	11.4	11.3	13.7	13.6	14.4	14.4	3.3	3.2	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
December	11.5	11.3	13.8	13.7	14.1	14.0	3.3	3.0	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
Average for 1900	**11.6**		**14.3**		**14.0**		**3.2**		3.7		3.7		4.2		4.1	
Average for 1899	**10.4**		**14.4**		**11.1**		**3.3**		3.7		3.6		4.2		4.0	
Average for 1898	**11.0**		**12.4**		**10.5**		**2.8**		3.6		3.7		4.4		4.1	

AVERAGE RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH IN CRUDE MATERIALS.

With few exceptions, the samples of raw materials analyzed in 1900 were taken from goods in the hands of farmers, and had been bought for cash direct from the manufacturers of complete fertilizers. After an analysis of the samples, therefore, it was not difficult to calculate the retail prices per pound of the various forms of nitrogen, phosphoric acid and potash used in this trade.

The tables on pages 37 to 39, in the report of 1900, furnish in detail the information gained by this work, and afford data also for the following summary. For comparison, results secured in a similar manner in 1894, 1895, 1896, 1897, 1898 and 1899, are republished:

COST PER POUND OF—	1894.	1895.	1896.	1897.	1898.	1899.	1900.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.
Nitrogen ftom Nitrate of Soda	14.8	13.4	12.7	12.9	12.8	12.2	12.9
" " Sulfate of Ammonia	18.8	....	13 8	11.8	14.0	14.8	15.8
" " Dried Blood	16.7	13.8	11.9	11.8	11.5	12.9	14.0
" " Dried Fish	17.5	16.4	13.7	12.8	11.5	13.8	13.7
" " Ammonite	....	14.9	....	....	....	13.5	14.4
Soluble Phosphoric Acid from Bone Black	6.5	5.8	5.6	5.8	....	....	....
" " " " S. C. Rock	4.7	4.8	4.5	3.6	3.3	3.7	4.1
Reverted " " " Bone Black	6.5	5.8	5.6	5.8	....	....	....
" " " " S. C. Rock	4.7	4.3	4.5	3.6	3.3	3.7	4.1
Potash from High-Grade Sulfate	4.9	4.5	4.8	4.9	4.0	5.3	4.3
" " Double Sulfate of Potash and Magnesia	....	....	4.5	5.2	4.3	....	....
" " Kainit	4.8	4.7	4.7	4.3	4.0	4.5	3.4
" " Muriate	4.1	3.9	4.0	4.1	3.8	4.0	4.1

These averages are the *manufacturers' retail cash prices for the nitrogen, phosphoric acid and potash in the crude stock from which complete fertilizers are made.*

COMPARISON BETWEEN THE AVERAGE WHOLESALE AND RETAIL PRICES OF NITROGEN, PHOSPHORIC ACID AND POTASH.

The conclusions reached in regard to the wholesale and retail prices are here tabulated. They represent the manufacturers' *wholesale and retail prices* for plant-food *in its best forms.* The percentages by which the retail prices exceed the wholesale have been taken as the basis of the comparison.

	Manufacturers' Averages.				Average Percentage by which the Retail Prices Exceed the Wholesale.		
	Wholesale prices for 1899.	Retail prices for 1899.	Wholesale prices for 1900.	Retail prices for 1900.	1898.	1899.	1900.
	cts.	cts.	cts.	cts.			
Nitrogen from Nitrate of Soda	10.4	12.2	11.6	12.9	11.8	17 8	11.2
" " Sulfate of Ammonia	14.4	14.3	14.2	15.8	12.9	*0.7	11.3
" " Dried Blood	11.1	12.9	14.0	14.0	9.5	16.2	....
" " Dried Fish	....	13.3	....	13.7	....	....	....
" " Ammonite	....	13.5	....	14.4	....	....	....
Soluble Phosphoric Acid from Bone Black	....	....	....	....	....	....	....
" " " " S. C. Rock	3.3	3.7	3.2	4.1	17.9	12.1	28.1
Reverted " " " Bone Black	....	....	....	....	....	....	....
" " " " S. C. Rock	3.3	3.7	3.2	4.1	17.9	12.1	28.1
Potash from High-Grade Sulfate	4.0	5.3	4.1	4.8	*2.5	32.5	17.1
" " Double Sulfate of Potash and Magnesia	4.2	....	4.2	....	*2.8	....	....
" " Kainit	3.7	4.5	3.7	3.4	11.1	21.6	*8.8
" " Muriate	3.6	4.0	3.7	4.1	2.7	11.1	10.8

*Wholesale price exceeds retail.

II.

THE CHEMICAL EXAMINATION OF FERTILIZERS.

1. *Introduction.*
2. *The trade values of fertilizing idgredients for 1901, and the examination of the standard materials supplying them.*
3. *The examination and valuation of manufactured brands, home mixtures, special compounds and sundry materials.*

1.

INTRODUCTION.

The Fertilizer Law.

The fertilizer law of this State is as follows :

An act to regulate the manufacture and sale of fertilizers [approved March 24th, 1874, and amended March 27th, 1878.]

1. That every commercial fertilizer which shall be offered for sale in this State shall be accompanied by an analysis, stating the percentage therein of ammonia, or its equivalent of nitrogen ; of potash, in any form or combination, soluble in distilled water ; and of phosphoric acid in any form or combination ; the portion of phosphoric acid soluble in distilled water ; that portion soluble in a neutral solution of citrate of ammonia at a temperature not exceeding one hundred degrees Fahrenheit ; and that portion of phosphoric acid not soluble in either of the above-named fluids, shall each be determined separately ; and the material from which the phosphoric acid is obtained shall also be stated ; a legible statement of such analysis shall accompany all packages or lots of over one hundred pounds sold, offered or exposed for sale.

5. That any person selling, offering or exposing for sale any commercial fertilizer without the analysis required by the first section of this act, or with an analysis stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, shall forfeit fifty dollars for the first offense and one hundred dollars for each subsequent offense ; *provided, further,* that the provisions of this section shall not apply to any manure sold at a price not exceeding one-half a cent per pound, nor to any imported guanos.

From the Station's standpoint this involves :

1. The securing of samples.

2. The selection of the samples for examination.

2. The chemical analysis.

1. The Securing of Samples.

In order that the inspection of fertilizers may be of value to the State, it is necessary that the samples analysed should be beyond question as to having been properly taken and carefully preserved, so as to fairly and justly represent the bulk of the material from which they are drawn. Success in this particular depends as much on experience, is often as difficult to attain and is quite as important as the subsequent chemical work in the laboratory. For this reason the samples analysed under the act are with a few exceptions taken by duly-authorized Inspectors, many of whom have been doing this work for the Station for years. These gentlemen are farmers of the highest standing in the community, and are willing to assume this duty solely because it is regarded as a matter of vital interest to the farming public.

The names of those who have represented the Station during the past season are as follows :

INSPECTORS FOR 1901.

CHAS. KRAUS	Egg Harbor City	Atlantic county.
J. HECK	Westwood	Bergen county.
H. I. BUDD	Mount Holly	Burlington county.
SAMUEL WOOD	Haddonfield	Camden county.
J. H. RICHARDSON	Rio Grande	Cape May county.
H. O. NEWCOMB	Cedarville	Cumberland county.
J. B. WARD	Lyons Farms	Essex county.
J. C. GRISCOM	Woodbury	Gloucester county.
AUGUSTUS DILTS	Flemington	Hunterdon county.
J. M. DALRYMPLE	Hopewell	Mercer county.
W. T. WOERNER	New Brunswick	Middlesex county.
HENRY D. HANCE	Freehold	Monmouth county.
J. J. MITCHELL	Troy Hills	Morris county.
WOODNUTT PETTIT	Salem	Salem county.
H. S. VAN NUYS	Millstone	Middlesex county.
D. N. WARBASSE	Newton	Sussex county.
F. E. WOODRUFF	Cranford	Union county.
W. O. WARD	Hainesburg	Warren county.

At the beginning of the season each Inspector is furnished with a sampling tube, blanks for describing samples, bottle labels, etc., together with printed instructions regarding their use. Each Inspector is requested to secure a sample of every brand of commerical fertilizer that he can find in his district.

2. The Selections of the Samples for Examination.

As fast as the samples are secured they are shipped to the Station. Many duplicates are received, but all are given a distinguishing number and properly stored, and an entry is made for each in an appropriate book, showing at a glance the name of the brand and the place or places where it has been found. From among the duplicates of each brand a selection is made at random, but with the aim in view of causing the analyses representing any one firm to be of samples drawn from as many different counties of the State as possible.

This method of selection, it is believed, is more likely to cause the analyses to demonstrate the general quality of a manufacturer's product and to disarm any suspicion or insinuation on the part of rival dealers that the goods were specially prepared to be sampled, which might arise if the sample analysed was taken upon request.

Under certain conditions, however, this rule is not strictly adhered to. When purchases are to be paid for according to the Station's analysis and their magnitude warrants, or when the analysis will add to the information of the Station, or will demonstrate a possible development of waste products into cheap sources of plant-food, or in other ways is of general interest, the Station performs the work free of charge; but in all cases it requires that full and sufficient information concerning the sample be furnished, in order that there may be no unnecessary duplication of work, and when accomplished, the analysis may be of service to the general public.

The following is a list of those business houses the analyses of whose goods are published in this report:

Manufacturers

WHOSE GOODS HAVE BEEN SAMPLED AND ANALYSED THIS YEAR.

J. H. Allen... Lawrence Station, N. J.
Allentown Manufacturing Co... Allentown, Pa.
American Agricultural Chemical Co.................. No. 26 Broadway, New York City.
H. J. Baker & Bro. Branch............................ 93 William St., New York City.
Bradley Branch.. New York City.
Chemical Co. of Canton Branch.................... 32 S. Charles St., Baltimore, Md.
Chicopee Guano Co. Branch............................... 88 Wall St, New York City.
Great Eastern Branch... Rutland, Vt.
Pacific Guano Branch... New York City.
Packers' Union Branch................................ 150 Nassau St., New York City.
Moro Phillips Branch............................ 710 The Bourse, Philadelphia, Pa.
Preston Branch... Greenpoint, L. I., N. Y.

The Quinnipiac Co. Branch............New York City.
Read Branch............16 Exchange Place, New York City.
Sharpless & Carpenter Branch............710 The Bourse, Philadelphia, Pa.
Susquehanna Branch............Baltimore, Md.
Tygert-Allen Branch............2 Chestnut St, Philadelphia, Pa.
Williams & Clark Branch............27 William St., New York City.
Armour Fertilizer Works............205 La Salle St., Chicago, Ill.
Warren Atkinson............Mullica Hill, N. J.
James H. Baird............Marlboro, N. J.
Baugh & Sons Co............20 S. Delaware Ave., Philadelphia, Pa.
The Berg Co............Russell and Bath Sts., Philadelphia, Pa.
A. Berg Glue Co............Ontario St., Philadelphia, Pa.
Berger Bros............Easton, Pa.
Bowker Fertilizer Co............No. 43 Chatham St, Boston, Mass.
Bradley & Green Fertilizer Co............9th St. and Girard Ave., Philadelphia, Pa.
W. M. Brown............Cedarville, N. J.
E. Frank Coe Co............133 Front St., New York City.
John S. Collins & Son............Moorestown, N. J.
Collins & Pancoast............Merchantville, N. J.
Peter Cooper's Glue Factory............13 Burling Slip, New York City.
I. S. Curtis............Frenchtown, N. J
Davis, Colson & Co............Woodstown, N. J.
B. F. Demarris & Son............Cedarville, N. J.
J. H. Denise............Freehold, N. J.
J. Y. Dilatush............Robbinsville, N. J.
H. W. Doughten............Moorestown, N. J.
Runyon Field............Bound Brook, N. J.
J. C. Fifield Sons & Co............Bakersville, N. J.
L. Fischer............Belford, N. J.
Fithian & Pennell............Bridgeton, N. J.
Geo. B. Forrester............159 Front St., New York City.
W. O. Garrison............Bridgeton, N. J.
J. C. Griscom............Woodbury, N. J.
F. E. Hancock............Walkerton, Ontario, Canada.
Wyckoff Hendrickson............Allentown, N. J.
S. M. Hess & Bro............Reading, Pa.
Ira Hill............Copper Hill, N. J.
Hill & Co............Flemington, N. J.
Hires & Co............Quinton, N. J.
International Seed Co............Rochester, N. Y.
The Keystone Chemical Co............Camden, N. J.
F. R. Lalor............Dunnville, Ont., Can.
Lister's Agricultural Chemical Works............Newark, N. J.
The Mapes F. & P. Guano Co............143 Liberty St., New York City.
Frank Maul............Greenwich, N. J.
Hugh McAnany............19 N. Juniper St., Philadelphia, Pa.
John E. Minch............Bridgeton, N. J.
Mixner & Mickel............Bridgeton, N. J.
Monmouth Chemical Works............Shrewsbury, N. J.

G. L. Monroe .... Oswego, N. Y.
Albert Nelson & Co .... Allentown, N. J.
Wm. C. Newport & Co .... Willow Grove, Pa.
James E Otis .... Tuckerton, N. J.
S. L. Pancoast .... Mullica Hill, N. J.
Peterson & Smith .... Woodstown, N. J.
Philadelphia Morocco Co .... Philadelphia, Pa.
Enos Richmond .... Elmer, N. J.
Edward Rigg, Jr .... Burlington, N. J.
M. F. Riley .... Elmer, N. J.
James Ross .... Trenton, N. J.
Ruckman Bros .... New Brunswick, N. J.
Russell Agricultural Chemical Co .... Newark, N. J.
Saul & Johnson .... Erma, N. J.
Sharpless & Bro .... Camden, N. J.
M. L. Shoemaker & Co .... Delaware Ave. and Venango St., Philadelphia, Pa.
Lester Shurts .... Neshanic, N. J.
L. W. Sickler .... Glassboro, N. J.
Rufus W Smith .... Elmer, N. J.
Somerset Chemical Co .... Bound Brook, N. J.
Stevens Bros .... Cedarville, N. J.
Swift & Co .... Chicago, Ill.
Henry Taylor .... Vineland, N. J.
The Taylor Provision Co .... Trenton, N. J.
I. P. Thomas & Son Co. .... 2 S. Delaware Ave., Philadelphia, Pa.
Trenton Bone Fertilizer Co .... Trenton, N. J.
The J E. Tygert Co .... 42 S. Delaware Ave, Philadelphia, Pa.
The Tyler-Hall Chemical Co .... Readburn, N. Y.
Vineland Grain Co .... Vineland, N. J.
Emil Wahl Mfg. Co .... No. 3870 Pulaski Ave., Nicetown, Philadelphia, Pa.
Warren Fertilizer Works .... Belvidere, N. J.
Geo. M. Wells .... Moorestown, N. J.
West Jersey Marl and Transportation Co .... Woodbury, N. J.
W. E. Whann .... William Penn, Pa.
Winterbottom, Carter & Co .... Egg Harbor City, N. J.

3. The Chemical Analysis.

The chemical analysis includes a test for the three forms of nitrogen, viz., as nitrates, as ammonia salts and as organic matter, and a quantitative determination of each when found. Likewise the total phosphoric acid is determined, and also that portion of it which is soluble in water, and that soluble and insoluble in ammonium citrate solution.

Potash and chlorin determinations are also made, and when potash is found in excess of that needed to form muriate of potash with the chlorin present, it is credited to the manufacturer as being in the form of sulfate. Brands in which the latter has been the case are designated in the tables by an asterisk in the potash column.

This complete examination is of value in furnishing information regarding the kind and quality of the materials used in mixed fertilizers.

The section of the fertilizer law published in the introduction to this chapter, indicates that in this State certain analyses must be made according to prescribed methods; in the others the methods to be used are left to the judgment of the officers of the Station, and are those recommended by the Association of Official Agricultural Chemists.

2.

THE TRADE VALUE OF FERTILIZING INGREDIENTS FOR 1901, AND THE EXAMINATION OF THE STANDARD MATERIALS SUPPLYING THEM.

In most States in which a fertilizer control is exercised it is customary to estimate and affix a commercial valuation to the various materials analysed. This estimated commercial value, it must be clearly understood, is separate and distinct from the agricultural value, the latter depending upon the character and form of the material with reference to its availability and the needs and value of the crop for which it is to be applied. The former, on the other hand, is determined by market and trade conditions, such as supply and demand, the cost of production, the methods of manipulations required, etc. It is derived by applying to the various forms of plant-food ingredients, as shown by analysis, the values previously determined upon for them. These values are fixed from year to year, and are altered according to the cost of the standard materials containing these forms of plant-food, as shown in market reports and actual transactions.

It is not asserted that this system shows absolutely the commercial value of each brand at the time that the sales were made, but only the relative commercial value of the different brands. It is not intended to be a guide to the agricultural value, even relatively, and therefore cannot mislead in this direction. It is a guide to the charges for mixing, handling and selling plant-food contained in the different brands as compared with other brands. Any system of comparison of brands must leave a great deal to the judgment of the purchaser; he must determine for himself whether he would rather that his phosphoric acid, for example, were more or less soluble, that the nitrogen should be derived from the more quickly-acting nitrate, or the more lasting organic forms, or whether for his purpose the muriate is just as good as the more expensive sulfate of potash. These conditions are indicated by the analysis which accompanies

the valuation, and the latter is not to be used in total disregard of the former. With these points clearly understood, a comparison of commercial values cannot be regarded as discriminating against specific manufacturers or particular brands.

The wholesale prices per pound of plant-food prevailing in New York during the six months immediately preceding March 1st last, were for nitrogen in nitrate of soda, 11.3 cents; in sulfate of ammonia, 13.7 cents, and in high-grade dried blood, 14.1 cents; for available phosphoric acid in acid phosphate, 3.2 cents, and for actual potash in muriate of potash, 3.7; in kainit, 3.7 cents; in double sulfate of potash and magnesia, 4.3 cents, and in high-grade sulfate of potash, 4.2 cents. A comparison of these figures with those of last year will show that there have been advances in the market prices of acid phosphate and of the ammoniates, or nitrogen-furnishing materials, sulfate of ammonia excepted; these advances have, however, been taken into account in arranging the schedule.

From this as a basis, therefore, the following schedule of trade values was arranged at a meeting of Station Directors and Chemists for use in Connecticut, Massachusetts, New York, Rhode Island, Vermont and New Jersey during the season of 1901:

Schedule of Trade Values Adopted by Experiment Stations for 1901.

	Cents per pound.
Nitrogen in Nitrates	14.0
" " Ammonia Salts	16.5
Organic Nitrogen in dried and fine ground fish, meat and blood, and in mixed fertilizers	16.0
" " " fine-ground bone and tankage	16.0
" " " coarse bone and tankage	12.0
Phosphoric Acid, soluble in water	5.0
" " " " ammonium citrate*	5.0
" " insoluble in fine bone and tankage	4.0
" " " " coarse bone and tankage	3.0
" " " " mixed fertilizers	2.0
" " " " fine-ground fish, cotton-seed meal, castor pomace and wood ashes	4.0
Potash as Muriate	4.25
" " Sulfate and in forms free from muriates (or chlorids)	5.0

*The solubility of phosphates, in ammonium citrate solutions, is seriously affected by heat. An act of the Legislature (see Laws of New Jersey, 1874, page 90) provides that in this determination the temperature used shall not exceed 100° Fahr.; in other States 150° Fahr. has been adopted. The higher the temperature the larger will be the percentage of phosphoric acid dissolved by ammonium citrate solutions, and the larger the amount of so-called "reverted" phosphoric acid in a ton of superphosphate at a given price the lower will be the price per pound of said acid. Consequently the Station valuation of phosphoric acid, soluble in ammonium citrate has been fixed at *four and one-half* cents per sound for Connecticut, Massachusetts, New York, Rhode Island and Vermont, and at *five* cents per pound for New Jersey.

Valuation of Fertilizing Ingredients in Fine-Ground Feeds.

Organic Nitrogen	14.5
Phosphoric Acid	4.0
Potash	5.0

The results of analysis of 59 samples of standard raw materials appear in tabulated form upon subsequent pages. They include samples of nitrate of soda, sulfate of ammonia, dried blood and ammonite, dried and ground fish, tankage, ground bone, hair manure, South Carolina rock superphosphates, muriate and sulfate of potash and kainit. The samples of nitrate of soda and sulfate of ammonia are of good quality. The dried blood and dried and ground fish, show considerable variability, as is usually the case, and the samples of the plain superphosphates and of the various forms of potash were of good quality, almost without exception.

Average Cost Per Pound of Plant-Food Constituents.

In connection with the analyses is given the cost per pound of the essential fertilizing ingredient which it supplies. This is derived by dividing the cost per ton of the material by the number of pounds of that ingredient in a ton, as determined by analysis. The samples represent actual transactions of farmers' clubs, and of individuals. Therefore, if the cost per pound of the nitrogen, phosphoric acid or potash in these samples (with the exception of a few, which were purchased under particularly unfavorable circumstances) be averaged, the result may be fairly assumed to represent the average manufacturers' actual retail price at factory for tne same, and admit of a comparison with the Station's price, which is intended to represent the retail cash cost per pound of the fertilizing ingredients contained in the raw materials before they have been mixed to form the various commercial brands.

COMPARISON BETWEEN WHOLESALE PRICES AND MANUFACTURERS' AVERAGE RETAIL PRICES OF PLANT-FOOD IN FERTILIZER SUPPLIES AS DERIVED FROM ACTUAL TRANSACTIONS, AND STATIONS' SCHEDULE FOR 1901.

AVERAGE COST PER POUND OF—	Wholesale, September, 1900, to March, 1901.	Manufacturers' average retail prices.	Stations' schedule of prices.
	cts.	cts.	cts.
Nitrogen from Nitrate of Soda	11.8	13.2	14.0
" " Sulfate of Ammonia	13.7	16 5	16.5
" " Dried Blood	14 1	15.4	16.0
" " Dried and Ground Fish	......	16.7	16.0
Phosphoric Acid, available	3.2	3.9	5.0
Potash from Muriate	3.7	4.2	4.25
" " Kainit	3.7	4.0	4.25
" " High-Grade Sulfate	4.2	4.4	5.0

A study of the foregoing table shows that the manufacturers' retail prices for plant-food are, on the average, 14.3 per cent. greater than the wholesale, and the prices in the Station's schedule, on the average, are 3.4 per cent. greater than these, which is a total advance of Station's prices over wholesale prices, on the average, of 18 per cent. The application of this schedule to the plant-food in mixed goods is, therefore, perfectly fair to the manufacturers in showing the relative commercial value of the different brands.

The Purchase of Fertilizer Ingredients.

The experience of the Station in the past, and a study of the analyses of the raw materials, leads to the development of some observations and suggestions in relation to the purchase of these materials. The absence of guarantee in many instances, and the variation from the same in others, gives rise to a belief that they may prove useful.

Nitrate of Soda.—This is a material quite uniform in composition, an inferior sample being exceptional. Such a sample was received in 1898 for the first time since the organization of the Station. The samples examined this year range from 15.62 per cent. to 15.98 per cent. of nitrogen, or from 95 to 97 per cent. of purity. Samples are occasionally slightly below the average, but, nevertheless, it may be said that, in general, it is safe to purchase this material without especial chemical examination, although, of course, it, as well as every other material, should be accompanied by a guarantee.

Attention, then, need be paid simply to obtaining it at the lowest price possible. The cost of nitrate of soda this year ranges from \$40 to \$43 per ton, a variation due not at all to the quality of the goods, but arising from the business methods and other conditions attending their purchase. These remarks apply in a similar manner to sulfate of ammonia, of which, however, comparatively little is used.

Animal Matter.—The animal fertilizing materials, such as dried blood, dried and ground fish, tankage, etc., are always more or less variable, and the samples of these materials this year are found to be no exception to the general rule. Thus the samples of blood vary in composition from 11.39 to 13.11 per cent. of nitrogen; those of dried and ground fish vary from 4.58 to 10.28 per cent. of nitrogen, and from 4.22 to 7.90 per cent. of phosphoric acid, with no relation between the amounts of nitrogen and phosphoric acid in the different samples, nor between them and the cost of the material. All these should be purchased, therefore, with a strict reference to guarantee and a comparison of the selling price therewith, or, better, on the "unit system" of purchase. Allowing 80 cents per unit for all the phosphoric acid they contained, and excluding those samples notably low grade, dried blood cost, on the average this year, \$3.08, and dried and ground fish \$3.34 per unit of nitrogen. This is respectively equivalent to \$2.53 and \$2.74 per unit of ammonia. Extreme prices were \$3.47 per unit of nitrogen in dried blood, and \$4.72 in dried and ground fish, equivalent to \$2.85 and \$3.87, respectively, per unit of ammonia. The Station rates this form of nitrogen, when found in complete fertilizers, at \$3.20 per unit of nitrogen, equal to \$2.62 per unit of ammonia.

Plain Superphosphates.—As usual, there is observed the same variation in composition and lack of relation between the composition and the price of the acid phosphates examined. They vary from 12.39 per cent. of "available," at \$14, to 15.48 per cent., at \$12 per ton, while the range in price is from \$9.45 to \$21.15. In the case of this material, also, the "unit system" will prove the more satisfactory method of purchase. The average cost per unit of "available" this year, excluding those samples of notably-deficient quality or excessive price, was 79 cents, ranging from 64 to 92 cents. The Station's allowance for this material in the valuation of mixed fertilizers is \$1 per unit.

Sales of acid phosphate between large dealers and the smaller firms are made on the unit basis. The examination of the samples this year emphasizes the value of this system. It lies entirely with

the farmer to receive the advantage of this method of purchase, as no difficulty will be experienced in making contracts with the manufacturers on this basis.

Potash Salts.—The potash salts, while usually of good quality, nevertheless often show considerable differences in chemical composition. The guarantees accompanying them are, however, somewhat of a guide as to their purity, and possibly as much could be gained in their economical purchase by accepting the guarantees as correct, and endeavoring to secure a lower ton price, as by insisting on the analysis and allowing the price to take care of itself. Muriate of potash is often purchased on the basis of 80 per cent. purity. If the analysis shows a variation above or below 80 per cent., the purchaser pays for the excess or is remunerated for the deficiency at the same rate of purchase. This is similar to the "unit basis," is fair alike to the purchaser and the dealer, and requires a chemical analysis. The average price this year has been about $41 per ton for muriate of potash of 80 per cent. purity, or 83 cents per unit of actual potash. The Station values this in mixed goods at 85 cents per unit.

The Unit System of Purchase.

The unit system of purchase, referred to above, is the system upon which the manufacturers of mixed fertilizers buy these same materials for themselves. It is simply "buying upon analysis," since the purchaser pays a certain sum, previously agreed upon, for every per cent. of the essential kind of plant-food actually contained therein, and for fractions of a per cent. in proportion. With this agreement the goods are delivered, an analysis is made and the correct amount paid over. The purchaser therefore pays for what he gets, and gets what he pays for; the only part that is left for him to control is the rate or amount per unit to be paid. The average cost per unit of nitrogen this year has been $2.64 in nitrate of soda, $3.08 in dried blood and $3.34 in dried and ground fish; that of "available" phosphoric acid has been 79 cents, and that of potash has been 83 cents. The actual price to be paid depends, as do prices under any system, upon the business methods of the individual purchaser, together with various other conditions, such as the distance from market, the state of trade, the time of year, the size of order and the length of credit. *Those who study the conditions of the market, make up their orders early, and by combining with others purchase in considerable quantities and for cash, will undoubtedly secure better quotations than those who buy at the busiest season of the year, in small lots at a time, upon long credit and from the first-comer.*

FORMS OF NITROGEN.

Readily and Completely Soluble in Water.

Station Number.	FROM WHOM RECEIVED.	Percentage of Nitrogen.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Material.
	Nitrate of Soda.		cts.	
1001	J. Fitzga, Somerville	15.98	12.52	$40 00
1029	A. H. Rogers, Hamilton Square	15.98	12.99	41 50
1065	C. C. Hulsart, Matawan	15.77	13.32	42 00
1189	J. W. Pincus, Woodbine	15.62	13.44	42 00
1244	J. M. Dalrymple, Hopewell	15.78	13.67	43 00
	Average Cost per Pound		13.19	
	Sulfate of Ammonia.			
1588	C. Kraus, Egg Harbor City	19.81	16.48	65 30

FORMS OF NITROGEN INSOLUBLE IN WATER.

Station Number.	FROM WHOM RECEIVED.	Percentage of Nitrogen.	Percentage of Phosphoric Acid.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Material.
	Dried Blood and Ammonite.			cts.	
0123	Wm. Dubon, Pittstown	12.85	0.48	15.28	$39 65
1086	C. C. Hulsart, Matawan	11.89	3.34	14.19	35 00
1190	J. W. Pincus, Woodbine	13.11	1.21	14.89	40 00
1539	C. Kraus, Egg Harbor City	12.83	1.38	17.23	45 30
	Average Cost per Pound			15.40	
	Dried and Ground Fish.				
0122	Wm. Dubon, Pittstown	5.14	5.61	*19.12	24 15
0136	M. C. Losen, Belford	10.28	6.54	12.05	30 00
0137	" "	9.38	7.90	15.82	36 00
1031	A. H. Rogers, Hamilton Square	8.89	7.25	16.21	33 00
1028	H. O. Newcomb, Cedarville	7.04	5.29	20.43	33 00
1040	" "	4.58	4.22	*23.60	25 00
1069	H. I. Budd, Mount Holly	8.12	7.46	16.03	32 00
1103	S. Wood, Haddonfield	8.89	6.77	15.84	32 00
1126	J. C. Griscom, Woodbury	8.26	7.64	17.49	35 00
1191	J. W. Pincus, Woodbine	8.84	5.94	15.14	30 00
1558	C. Kraus, Egg Harbor City	6.20	5.60	22.19	32 00
1562	" "	6.76	5.87	17.23	28 00
1555	" "	8.56	6.81	11.42	25 00
1542	" "	7.61	5.60	20.05	35 00
1556	" "	7.07	7.44	17.36	30 50
	Average Cost per Pound			16.71	

The phosphoric acid in every case has been valued at 4 cents per pound.

*Not included in the average.

FORMS OF NITROGEN INSOLUBLE IN WATER.

TANKAGE AND GROUND BONE.

Station Number.	FROM WHOM RECEIVED.	MECHANICAL ANALYSIS. Finer than 1/16 inch.	MECHANICAL ANALYSIS. Coarser than 1/16 inch.	PERCENTAGE. Nitrogen.	PERCENTAGE. Phosphoric Acid.	Cost of 2,000 lbs of Material.
1080	A. H. Rogers, Hamilton Square	....	....	6.58	12.82	$21 00
1192	J. W. Pincus, Woodbine	69	81	8.68	9.87	82 00
1450	D. N. Warbasse, Newton	82	18	5.00	18.06	26 00
1585	C. Kraus Egg Harbor City	86	14	7.20	11.67	82 00
*1198	J. W. Pincus, Woodbine	60	40	2.20	28.42	21 50

*Ground Bone.

TANKAGE AND GROUND BONE.

Station Number.		COST OF NITROGEN PER LB. IN— Finer than 1/16 inch.	COST OF NITROGEN PER LB. IN— Coarser than 1/16 inch.	COST OF PHOSPHORIC ACID PER LB. IN— Finer than 1/16 inch.	COST OF PHOSPHORIC ACID PER LB. IN— Coarser than 1/16 inch.
		cts.	cts.	cts.	cts.
1192	Tankage	15.84	11.88	8.96	2.97
1450	"	14.29	10.72	8.57	2.68
1585	"	16.87	12.28	4.09	8.07
1198	Ground Bone	12.85	9.64	8.21	2.41
Average Cost per Pound		14.84	11.13	3.71	2.78

HAIR MANURE.

Station Number.	FROM WHOM RECEIVED.	Nitrogen.	Phosphoric Acid.	Potash.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Material.
					cts.	
0129	B. F. Bishop, Rancocas	2.91	0.78	0.18	4.43	$8 00
1501	W. L. Moore, Swedesboro	8.96	0.67	0.07	2.60	5 00
Average Cost per Pound					3.52	

PLAIN SUPERPHOSPHATES.

Furnishing Soluble, Reverted and Insoluble Phosphoric Acid.

Station Number.	FROM WHOM RECEIVED.	PHOSPHORIC ACID. Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Available.	Cost of Available Phosphoric Acid per lb.	Cost of 2,000 lbs. of Material.
		%	%	%	%	cts.	
0120	Wm. Dubon, Pittstown	10.66	4.23	3.89	14.89	4.58	$18 65
0121	" " "	9.06	4.03	4.36	13.09	*8.08	21 15
1062	A. H. Rogers, Hamilton Square	8.76	4.93	3.55	13.69	4.20	11 50
1064	H. I. Budd, Mount Holly	12.50	2.58	1.81	15.08	4.14	12 50
1067	C. C. Hulsart, Matawan	9.90	4.68	3.12	14.58	4.13	12 00
1149	H. O. Newcomb, Cedarville	13.34	2.14	0.89	15.48	3.87	12 00
1194	J. W. Pincus, Woodbine	12.02	2.13	2.09	14.15	3.36	9 50
1260	H. I. Budd, Mount Holly	9.14	4.44	2.27	13.58	4.05	11 00
1494	J. M. Dalrymple, Hopewell	11.20	3.58	1.18	14.78	*5.41	16 00
1506	G. W. Jessup, Moorestown	7.04	7.57	2.16	14.61	3.23	9 45
1537	C. Kraus, Egg Harbor City	9.20	5.63	2.15	14.83	3.86	11 50
1620	H. I. Budd, Mount Holly	5.84	7.05	4.08	12.89	*5.65	14 00
	Average Cost per Pound					3.94	

* Not included in the average.

GERMAN POTASH SALTS.

Station Number.	FROM WHOM RECEIVED.	Percentage of Potash.	Cost of Potash per lb.	Cost of 2,000 lbs. of Material.
	Muriate of Potash.		cts.	
1002	J. Fitzga, Somerville	52.36	3.82	$40 00
1063	A. H. Rogers, Hamilton Square	49.45	4.04	40 00
1068	C. C. Hulsart, Matawan	45.61	4.38	40 00
1195	J. W. Pincus, Woodbine	50.44	3.87	39 00
1460	A. Dilts, Flemington	50.47	4.21	42 50
1536	C. Kraus, Egg Harbor City	43.36	4.84	42 00
1540	" " "	53.33	3.98	42 40
1609	J. W. Opie, Three Bridges	49.69	4.20	41 70
1610	" "	48.36	......	......
	Average Cost per Pound	......	4.17	
	High Grade Sulfate of Potash.			
1196	J. W. Pincus, Woodbine	50.19	4.38	44 00
	Kainit.			
1348	W. O. Ward, Hainesburg	13.17	3.99	10 50

3.

THE EXAMINATION AND VALUATION OF MANUFACTURED BRANDS, HOME MIXTURES, SPECIAL COMPOUNDS AND MISCELLANEOUS PRODUCTS.

On the following pages are reported the analyses of

308	samples of	Complete Fertilizers,
8	" "	Home Mixtures,
18	" "	Special Mixtures,
25	" "	Ground Bone,
37	" "	Miscellaneous Fertilizers and Sundry Materials, and
6	" "	Complete Fertilizers excluded from the regular classification.

The main object of this work is to determine by chemical analysis whether the *actual* composition of each of the various manufactured products corresponds with its *guaranteed* composition, as required by law. By a comparison of the two it is shown whether the material fulfills the claims of the manufacturer, and how far the guarantee given is a guide as to the amounts of plant-food actually delivered to the consumer. In addition, the application of the Station's schedule of values, which has been adopted for the various kinds and forms of fertilizer constituents, and is published on a previous page, demonstrates comparatively whether the selling prices are justified, and the amounts by which the latter exceed the commercial values derived from the analyses represent the comparative charges of the different manufacturers for mixing and bagging their goods and effecting their sale.

This work is of direct value to the intelligent and experienced purchaser in furnishing definite information relative to the composition and value of the different brands to which his attention may be called, and is of indirect value to all purchasers in that it tends to reduce to a minimum the amount of worthless material offered for sale.

I. Complete Fertilizers.

The number of distinct commercial brands of complete fertilizers, the analyses of which are herewith reported, is eight more than last year. They are the product of 79 manufacturers, which is five less than last year. It is, therefore, evident that there is an increase in the number of brands per manufacturer; this increase amounts to about three brands for every ten manufacturers, so that the average representation this year is three and nine-tenths brands, instead of three and six-tenths brands per manufacturer, as found in 1900.

The average number of brands apiece is, therefore, about 4 ; there are 57 manufacturers represented by this number or less, 14 represented by from 5 to 8 (twice the average), 7 by from 9 to 12 (three times the average), and 1 by 16 brands, or four times the average.

The extent to which multiplication of brands is in some cases carried would seem to be in excess of that needed for a range of choice, especially in those cases when the differences, to all practical purposes, are in name only. Whether it is warranted by commercial reasons is another question, for it is undeniable that manufacturers supply, as a rule, only that which consumers demand. The inspectors who represent the Station in the different counties have instructions to send a sample of every distinct brand they can find in their locality or district. Samples from any one manufacturer, and indeed of the same brand, are thereby received in many cases from several different counties, and this representation may be taken as a measure of this demand. From the limited extent to which many brands are found distributed throughout the State, it is a question whether this demand is as great as might be supposed.

The Chemical Composition.

The complete fertilizers examined this year show a great diversity as regards composition, for they include the association of almost every amount of nitrogen from 0.72 to 9.12 per cent. (equal to from about nine-tenths per cent. to over 11 per cent. of ammonia), with almost every amount of phosphoric acid (available) from 2.97 to 12.88 per cent., and almost every amount of potash from 0.63 to 12.94 per cent. The complete examination which has been made of every brand discloses also that still further differences in composition exist, in that some manufacturers use nitrate or ammonia salts as a partial source of their nitrogen, and others use animal matter entirely, such as blood, or meat; some use sulfate of potash, and others the muriate or kainit; some supply a relatively larger amount of water-soluble phosphoric acid, and others of citrate-soluble, accompanied by more or less of insoluble phosphoric acid, of which the guarantee takes no account in many instances.

The proportion of the phosphoric acid which each of the various brands supplies can be readily learned from an inspection of the tables which follow. The average analysis of all the brands is 4.59 per cent. of water-soluble, 3.49 of citrate-soluble and 2.40 of insoluble (or acid soluble) phosphoric acid. The use of sulfate of potash as

the source of any considerable portion of the potash is indicated by an asterisk (*) in the potash column. There are among the 308 brands but 34 in which this is the case. Potash as sulfate receives a higher valuation than when in the form of muriate, since it costs somewhat more.

Nitrate of soda is used as a partial source of nitrogen in 189 of the brands, and salts of ammonia in 69, both being used in 40 of them. The nitrogen supplied as nitrate has ranged from nothing to 7.37 per cent., the average being 0.92 per cent., and that supplied as salts of ammonia has ranged from nothing to 1.89 per cent., the average being 0.60 per cent. These have been associated with varying amounts of organic nitrogen, ranging from 0.03 per cent. to 4.55 per cent., and averaging 1.62 per cent. When comparison of these figures is made with those given last year, they would seem to indicate an increase in the use of the water-soluble forms of nitrogen (particularly of nitrate of soda) in respect both to the amounts and to the number of brands in which they occur.

Brand Names.

In few instances is the composition or character of these materials, containing, as they do, almost every practicable amount and proportion of plant-food in the different forms—in few instances is it accurately designated by the brand name. Manufacturers by no means agree as to the true formula for a "Potato Manure," for instance; "Dissolved Bone Phosphate" does not necessarily imply that a trace of bone has been used in its manufacture; "Ammoniated Bone Superphosphate" may contain bone, but does not indicate that it often contains potash, and many brands could easily be mistaken (from a consideration of name alone) for pure bone meal.

The necessity may be seen, therefore, of the published statement of analysis or guaranteed composition of each brand, which is required by law, and the importance of a conformity of the actual composition with it.

Guarantees and Actual Composition.

Without exception, all of the brands examined this year have been accompanied by a guarantee, as the fertilizer law of New Jersey requires shall accompany all packages or lots of over one hundred pounds sold, offered or exposed for sale. Nevertheless, there has been a rather unusually large number of instances this year of

erroneous guarantees. On analysis certain brands have shown a composition which made the accompanying guarantee absurd. Requests on the part of the Station have elicited from the manufacturers the explanation that the goods have been put up in wrong bags, or drawn from the wrong heap or bin, or the regular bags have been used for goods which have been fortified according to the order of a certain customer, by the addition of more than usual of a certain ingredient. Occurrences of this sort are particularly annoying to the officers of the Station. It is the practice of the Station to analyze one sample of each brand, and publish this as representing, to the best of its knowledge, the composition of this brand wherever found; and while it would seem to be the manufacturer's own fault, if through wrong bagging a usually superior brand were published with an inferior analysis, on the other hand, it would be manifestly unfair to all others if an inferior brand, through the same means, were published as containing the superior analysis wherever found in the State. In the case of fortified brands, likewise, the analysis found does not represent the goods which the manufacturer advertises in his circulars. The special addition of extra material to a formula constitutes a change in the formula, and makes the brand a special brand, which is not entitled to representation in the tables of commercial brands. The Station has this year cut out all such erroneous samples, and, when possible, substituted true samples for them. There are six such samples at the close of the tables, for five of which duplicates could not be secured. They are therefore published separately; the sixth also is included because it was sampled unofficially. Unfortunately, the state of the case is usually not discovered until the analysis has been made, and thus a repetition of work is entailed. This extra work has been sufficient this year to delay the issue of the fertilizer bulletin thirty days, and the Station, therefore, cannot promise for the future that samples will be duplicated in time for the results to be included in the bulletin.

Of the brands published in the tables, it will be noticed that in a little over one-half of them the guarantee of phosphoric acid is defective, either available or total phosphoric acid alone being guaranteed. The absence of guarantee of total in certain instances is commercially not of great importance, since the difference between its figures and those of the available gives the amount of insoluble, which is comparatively inexpensive. Agriculturally, however, when consumers scrutinize guarantees, in order to select brands in which the quickly-available phosphoric acid is accompanied by a desired amount of more slowly-available phosphoric acid, the guarantee

giving this information is of particular value. But when, on the other hand, total phosphoric acid alone is guaranteed, there is no information whatever afforded as to its availability—a very important matter in the choice of a fertilizer. Attention was first called to this point in 1897, when the number of cases was 24. In 1898, there were 13; in 1899, 12; in 1900, 4; and in the present report there are 7 such cases. In certain ones a low available should be expected from their brand names; for example, "Fish and Potash," "Pure Bone Phosphate," etc. The reverse is not true, however, for purchasers have no reason to expect high availability in any brand simply because its name should happen to suggest it, or because other manufacturers put out material under the same brand name which has high availability. Consumers should request a compliance with the law in all respects before they consent to purchase.

The average amounts of plant-food guaranteed in the brands, and the average amounts found by analysis, are as follows:

	Total. Nitrogen. Per cent.	Available. Phos. Acid. Per cent.	Actual. Potash. Per cent.
Average guaranteed.........................	2.17	7.60	5.34
Average found................................	2.31	8.08	5.75

From this it is evident that the fertilizers examined this year furnish, on the average, the amount of plant-food which they guarantee. A detailed examination of the tables shows, however, that many brands are furnishing much more than they guarantee, and thus cover up, in a consideration of averages, the shortcomings of others. It is poor comfort to a purchaser of one of the latter to hear that fertilizers on the average are up to guarantee, because what he loses his neighbor, perhaps, receives. Nevertheless, a scrutiny of the analysis of each brand, and a careful comparison of its actual composition with its accompanying guarantee, show that about 81 per cent. of them contain as much *total* plant-food as is claimed, but in only 65 per cent. of them is it distributed in the proportions which are stated. This is not as good a showing as usual, for the latter figure for the past three years has been, respectively, 71 for 1900, 69 for 1899, and 66 for 1898, or a steady improvement until this year.

The following table shows the number of brands deficient in one or more of the plant-food constituents compared with the same for 1895, 1896, 1897, 1898, 1899 and 1900. In compiling this table of deficiencies, any brand that failed to reach its guarantee of nitrogen by only 0.20 per cent., or its guarantee of phosphoric acid or potash by only 0.30 per cent., has not been included:

YEAR.	Number of Brands. Examined.	Found as guaranteed.	Found deficient.	Number of Deficiencies. Nitrogen.	Phosphoric Acid.	Potash.	Percentage Deficient.
1895	269	158	111	17	72	37	41
1896	329	211	118	30	52	56	36
1897	284	194	90	29	47	30	32
1898	303	201	102	43	29	49	34
1899	321	222	99	33	51	32	31
1900	298	214	84	33	35	31	29
1901	308	202	106	31	60	34	35

As indicated in the table, there are 125 deficiencies distributed among the 106 brands, 13 brands being deficient in two particulars and 3 brands in all three particulars of their guarantees. There are indeed many brands which, except for the allowances of two-tenths and three-tenths above stated, would be classed as deficient in more particulars than here reported.

Of the 106 considered deficient, 47 deliver the *value* of the plant-food guaranteed by containing an excess in some other form, showing a lack of skill or of carefulness in their preparation rather than an intent to defraud.

Station's Valuations and Selling Prices.

The Station's valuation per ton is derived by applying to the different constituents the schedule of prices already published; it is intended to show the retail cash cost of the amount of nitrogen, phosphoric acid and potash contained in one ton if they were bought at factory in the form of raw materials, unmixed. The difference between selling price and Station's value shows, therefore, the charge that is made for mixing, bagging, shipping and selling the several brands.

The selling price per ton entered in the tables is the price at the point where sampled. These prices differ in the various localities of

the State, due mainly to differences in freight rates from point of production to consumers' depot, the amount sold and commission charged. Nothing has been added to the valuations to represent these charges, the Station perferring to let the consumer make such calculations himself, whereby they will apply to his own conditions.

The average composition, estimated value and selling price of all of the brands of complete fertilizers examined each year for the past eleven years, together with the actual and the percentage difference by which the selling price exceeds the valuations, are shown in the following tabulation :

YEAR.	Total Nitrogen.	Total Phos. Acid.	Available Phos Acid.	Insoluble Phos. Acid.	Potash.	Station's Valuation.	Selling price.	Actual difference.	Percentage difference.
1891	2 71	10.12	7.29	2 83	4 21	$25 31	$34 23	$8 92	35.2
1892	2.74	10.38	7.70	2 67	4 50	25 66	34 19	8 53	33 2
1893	2 69	10 23	7.54	2.69	4.58	24 41	34 11	9 70	39.7
1894	2.87	10.40	7.37	3 03	4.94	24 83	34 17	9 31	37.6
1895	2.80	10 74	7 84	2.90	4 80	24 15	32 87	8 72	36.1
1896	2 51	10.86	8.21	2 65	5.02	21 70	30 33	8 63	39.8
1897	2.54	10.93	8 01	2.91	5 01	21 58	29 28	7 70	35.7
1898	2 45	10 69	8 37	2 32	5.38	19 90	28 58	8 68	43.6
1899	2.41	10 58	8 27	2 31	5.67	19 95	27 75	7 80	39.1
1900	2.30	11.03	8.44	2.59	5.89	20 77	27 26	6 49	31.2
1901	2.31	10.48	8.08	2.40	5.77	21 19	27 31	6 12	28.9

It will be observed that the tendency of the average fertilizer toward a lower content of nitrogen is checked, notwithstanding an increase in the wholesale price of ammoniates ; manufacturers, as a whole, therefore, seem to have offset this increase by reducing the content of phosphoric acid and potash in their fertilizers, apparently believing that content of nitrogen has, on the average, reached its minimum, and that it would be bad policy to increase prices. The composition of the average fertilizer for 1901 may, therefore, be said to approximate to the following analysis :

Nitrogen	2.25	per cent.
Equal to Ammonia	2.75	"
Phosphoric Acid, total	10.50	"
" " available	8.00	"
Actual Potash	5.75	"
Equal to Sulfate of Potash	10.50	"

Station's Valuation, per ton	$21 00
Selling Price, per ton	27 00

As noted on a previous page, there have been increases in the schedule for the valuation of complete fertilizers, whereby two of the forms of nitrogen, as well as both forms of available phosphoric acid, are given higher values than last year, as follows:

	Valued in 1900 at	Valued in 1901 at
Nitrogen in Nitrates	13.5 cents.	14.0 cents.
" " Ammonia Salts	17.0 "	16.5 "
" " Organic Matter	15.5 "	16.0 "
Phosphoric Acid, soluble in water	4.5 "	5.0 "
" " " " ammonium citrate	4.5 "	5.0 "

The price for the valuation of potash, however, remains the same. It becomes of interest, therefore, to determine whether there is an equivalent amount of plant-food delivered with this change in the average formula. This is readily determined by calculating the valuation of the average complete fertilizer of each of the two years by means of the same schedule. In this manner the Station's valuations, calculated for the two years, according to last year's schedule, compared with the selling prices, are shown as follows:

	Station's Valuation.	Selling Price.	Actual Difference.
1900	$20 77	$27 26	$6 49
1901	20 19	27 31	7 12

From this it appears that the manufacturers are delivering on the average somewhat less total plant-food than in 1900, but at about the same price per ton. The increase in the schedule of valuations brings the average actual difference and the percentage difference lower than ever before. These differences have been remarkably uniform in the past, which renders it worthy of note that the rise in the cost of raw materials, and the consequent increase in the schedule of valuations, have not been accompanied by a marked increase in the average selling price.

Taking the valuations and selling prices as they are, however, the average difference is $6.12, which represents the average charge of the entire number of manufacturers for mixing and bagging an average of about $21 worth of plant-food, and for the expenses incurred in a great variety of ways in effecting its sale and delivery. That manufacturers do not make this average charge in all cases is apparent from an examination of the tables. Thus, there will be found 7 brands in which the value of the plant-food at Station's prices is equal to or greater than the price reported, 148 other brands in which the differ-

ence is still below the average, namely, $6.12, 36 more with a difference of $7, 35 with a difference of $8, 27 differing by $9, 14 by $10, 13 by $11, 11 by $12, and 16 differing by from $13 upwards, all approximately.

In calling attention to this wide range of difference between Station's valuation and the selling price, the Station wishes not only to emphasize the fact that plant-food has been and is being purchased at or below the Station's schedule of prices, but also to warn the reader against the hasty conclusion on the other hand, that fraud enters into the transaction when the selling price exceeds the valuation. It may be that there are cases in which guarantees are given and fulfilled, and yet an extravagant price shrewdly asked for the goods, entirely out of proportion to the amount of plant-food offered; yet, on the other hand, it must be remembered that the selling prices in the tables are those reported from the places where the goods were sampled. In most cases they include, therefore, not only the factory expenses of mixing and bagging, the office expenses, the salaries of clerks and bookkeepers, but also the freight and the local agent's commissions, none of which are included in the Station's valuation. Besides these, also, the selling price includes in many instances, in addition to the expenses of getting the fertilizer on the market, the expenses of a more or less successful collection of the payment for the same. The Station could note numerous cases in which lower prices for cash are quoted, and farmers buying a bag at a time on indefinite credit cannot hope for as favorable rates as those who club together to buy a carload for spot cash, whereby all the expenses from the time the goods leave the manufacturer's warehouse until the payment reaches his office are reduced to a minimum. Under these circumstances, few, if any, of the large manufacturers will decline to sell at about the Station's valuation, and there are numerous instances on record of their having done so, as may be gathered from the succeeding paragraph.

2. The Examination of Home Mixtures and Special Compounds.

Home mixing has been carried on with entire satisfaction by a number of farmers for several years. The Station has encouraged these efforts as of value to the individuals themselves and an object-lesson to their neighbors, since it renders them familiar with the kinds and forms of plant-food, teaches them to think of pounds of nitrogen, phosphoric acid and potash, rather than tons of a particu-

lar phosphate, and in general unfolds the mystery which envelops the make-up of fertilizers in the minds of many.

For similar reasons, the Station has assisted by making the analysis of complete fertilizers specially compounded for farmers by the regular manufacturers. In the case of most of these mixtures, the analysis desired, or the raw material to be used, was specified by the purchaser and guaranteed by the manufacturer. The ingredients used in the home mixtures were, so far as reported to us, as follows :

Composition of Home Mixtures.

No. 1090.

100 lbs. Nitrate of Soda.
1,200 " Chicken Manure.
550 " Acid Phosphate.
150 " Muriate of Potash.

No. 1581.

160 lbs. Nitrate of Soda.
240 " Dried Blood.
1,240 " Acid Phosphate.
360 " Muriate of Potash.

No. 1580.

975 lbs. Dried Fish.
800 " Acid Phosphate.
225 " Muriate of Potash.

No. 1505.

200 lbs. Nitrate of Soda.
100 " Sulfate of Potash.
100 " Dried Blood.
1,200 " Degelatinized Bone.
400 " Muriate of Potash.

No. 1583.

1,440 lbs. Ground Bone.
560 " Muriate of Potash.

The analyses of the home mixtures and of the specially compounded mixtures are to be found on a subsequent page among the tables. The most striking fact which may be learned from a study of them is shown in the following comparison of the average composition, valuation and cost of the home mixtures, of the special compounds and of the regular commercial brands :

	Total Nitrogen.	Total Phos. Acid.	Available Phos. Acid.	Insoluble Phos. Acid.	Potash.	Station's Valuation.	Selling price or cost.	Actual difference.	Percentage difference.
Special Compounds..	2.24	12.08	9.71	2.37	6.16	$23 15	$24 44	$1 29	5.6
Home Mixtures	2.43	11.39	8.66	2.73	6.86	23 34	26 00	2 66	11.4
Regular Brands......	2.31	10.48	8.08	2.40	5.77	21 19	27 31	6 12	28.9

The table shows that, on the average, the regular brands sold at an advance over Station's valuation of 28.9 per cent., the home mixtures cost at an advance of 11.4 per cent. and the special compounds at an advance of 5.6 per cent. In other words, $100 worth of plant-food, according to the Station's schedule of prices (which are wholesale prices plus 18 per cent.), cost $105.60 when purchased in the form of special compounds, $111.40 in the form of home mixtures, and 128.90 in the form of regular commercial brands. Moreover, the range in the relation of price to guarantee is narrower in the former two than in the latter; for the greatest individual advance of selling price over valuation is $6.19 in the home mixtures, and $10.53 in the special compounds, whereas in the regular commercial brands the average advance was $6.12, and 40 brands had a difference of $11 or more.

This indicates the advantage of either home mixing or of special mixing by the manufacturer to suit the wants of the consumer. The saving by these methods is great; to use them to advantage, however, the farmer must have definite knowledge as to the requirements of his soils and crops, and in supplying the same must use business-like methods in the purchase of his fertilizer supplies.

Among the special compounds are a number which were prepared by I. P. Thomas & Son Co., and which bear the same brand name and guarantee as certain of their regular brands. The analyses of the regular brands are to be found in their regular places in the tables. These brands are inserted here because they are special compounds, having been fortified, or improved, by being made stronger for particular customers. It will be noticed that these have also undergone an advance in price, but it should also be noticed that while the improvement consists in the supplying of about 42 per cent. more plant-food, the price has been increased only 6 per cent., a difference of 36 per cent. There is no reason to believe that any of the manufacturers would decline to make this concession to large sales and quick profits.

3. Ground Bone.

The samples of ground bone examined this year are, with exceptions, of as good composition, but not of as good quality as regards fineness as last year. There are only five, or one-fifth, of them in which two-thirds of their material will pass the sieve, whereas last year there were thirteen such, equal to one-half the brands examined. Several are not accompanied by a guarantee as required by law, but

in most of these cases, as well as in those in which the guarantee is not fulfilled, the analysis shows them to contain a sufficient quantity of plant-food to render an equivalent of value. One notable exception must have attention directed to it; sample No. 0125 was found to have a much lower quality than should be expected from the price. Investigation disclosed that it contains considerable substance that is not bone. The matter was communicated to the manufacturer, who immediately ordered a rebate to those to whom it had been sold. This sample, and two others which are samples of 1900, analyzed too late for last year's bulletin, are excluded from consideration when calculating averages.

The average fineness and composition of the samples this year, as compared with 1899 and 1900, is shown as follows:

	Fine. Per cent.	Coarse. Per cent.	Nitrogen. Per cent.	Phosphoric Acid. Per cent.
Average for 1899......	49	51	3.17	22.83
" " 1900......	63	37	3.24	23.33
" " 1901......	52	48	3.20	24.20

The composition of the different samples (three excluded as noted) varied from 1.45 to 5.38 per cent. of nitrogen and from 17.50 to 28.70 per cent. of phosphoric acid. There is somewhat of a relation between the two, a high nitrogen content being usually accompanied by a low phosphoric acid, and *vice versa*, but this relation is by no means invariable.

Valuation of Bone.

In the schedule of valuations of bone this year, three changes were made, an increase of half a cent for the nitrogen in the finer grade, and of one cent each for both nitrogen and phosphoric acid in the coarser grade.

The following table shows the schedule used as compared with that of 1900:

	Nitrogen. Per pound.		Phos. Acid. Per pound.	
	1900. cts.	1901. cts.	1900. cts.	1901. cts.
Finer than 1-50 inch...............	15.5	16.0	4.0	4.0
Coarser " 1-50 "	11.0	12.0	2.0	3.0

An examination of the valuations given in the table shows that they vary from \$19.93 to \$32.60 per ton, while the selling prices range from \$22 to \$35. The average valuation and average selling price is compared with the same figures for 1899 and 1900, as follows :

Year.	Station's Value.	Selling Price.	Difference.
1899	\$21 24	\$28 20	\$6 96
1900	25 88	28 70	2 82
1901	26 09	28 98	2 89

The excess of selling price over valuation is much less in ground bone than in complete fertilizers, being about 11 per cent., whereas that in complete fertilizers is about 29 per cent. The nitrogen and phosphoric acid in ground bone, therefore, are still much cheaper than when bought in the form of complete fertilizers.

4. Miscellaneous Fertilizers.

Of the 17 samples of miscellaneous fertilizers, one is a complete fertilizer analyzed too late to be included in the regular classification, 7 represent commercial materials furnishing nitrogen and phosphoric acid, and 8 furnishing phosphoric acid and potash ; they consist either of true dissolved bone or plain superphosphate of lime, with ammoniates or potash salts added. There is one plain superphosphate. As in the case of complete fertilizers, the brand names of many of these materials are misleading. Samples branded "dissolved bone," "soluble bone," "alkaline bone," etc., may contain no animal bone as such, but plain rock superphosphate. Particular reference to the guarantee should be made in these, and, indeed, in all instances. In most of those which are accompanied by a guarantee, the actual analysis substantiates the same. Several of these preparations are not economical sources of plant-food, although the majority are much better than the average complete fertilizer in this respect. From an agricultural standpoint, care is required in the use of these unbalanced mixtures. In the case of the plain superphosphate, no valuation has been affixed ; the cost per pound of available phosphoric acid, calculated from the content and from the selling price, is 7.9 cents.

The 9 samples of wood ashes examined show the usual variations in content of potash, although their phosphoric acid is quite uniform. Still the recognized favorable effect of wood ashes is undoubtedly due as much to the lime contained as to the phosphoric acid and

potash. To farmers who desire to apply lime, wood ashes have an increased value, dependent upon the price at which they can purchase the lime in other forms in their own neighborhood. This value the Station does not undertake to determine, and hence the valuations of wood ashes are based only upon their content of phosphoric acid and potash, at the rate of 4 cents and 5 cents per pound, respectively. The lime which accompanies them may be more or less expensive. Allowing Station's valuations for the phosphoric acid and potash, the lime cost in the various samples from 35 cents to $1.03 per hundred weight, and almost invariably cost less as the amount of phosphoric acid and potash increased.

The remainder of the miscellaneous materials are factory wastes or natural products, which were examined to determine their character as sources of plant-food. They include three samples of wool waste, five of marl, and one each of snuff sand, garbage refuse and common lime. Their analyses will be found on the pages at the end of the tables.

Immediately following will be found the analyses of six samples of complete fertilizers, of which five are manifestly fortified goods, and probably for special customers, although this fact could not be definitely ascertained. The results are published separately, on account of this lack of knowledge. With them is a sample of Evans Brand, Potato Manure; this was sampled by a private party and analyzed at his request, and a duplicate sample was analyzed for the regular report.

4

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
J. H. Allen, Lawrence Station, N. J.		
Complete Phosphate	J. M. Dalrymple	1354
Potato and Truck Manure	"	1376
American Agricultural Chemical Co., New York City.		
H. J. Baker and Bro. Branch.		
Harvest Home	J. J. Mitchell	1511
Vegetable, Vine and Potato	H. S. Van Nuys	1165
Standard UnXld Fertilizer	J. Heck	1221
High-Grade Special	J. J. Mitchell	1514
Corn and Oats Manure	J. Heck	1224
Potato Manure	J. M. Dalrymple	1248
Bradley Fertilizer Co. Branch.		
Potato Fertilizer	D. N. Warbasse	1432
Complete Fertilizer, New Method	J. J. Mitchell	1517
Potato Manure	"	1518
Patent Superphosphates	"	1520
Chemical Co. of Canton Branch.		
Truckers' Delight	C. Kraus	1562
Chicopee Guano Co. Branch.		
Farmers' Reliable	J. B. Ward	1598
Standard	"	1599
A 1 Vegetable and Potato Manure	"	1600
Great Eastern Fertilizer Co. Branch.		
Garden Special	C. C. Hulsart	1069
Vegetable, Vine and Tobacco	J. Heck	1218
Pacific Guano Co. Branch.		
High-Grade General	H. S. Van Nuys	1176
Ammoniated Dissolved Bone	"	1177
Packers' Union Fertilizer Co. Branch.		
Universal Fertilizer	C. Kraus	1570
Animal Corn Fertilizer	J. M. Dalrymple	1366
Potato Manure	H. O. Newcomb	1058
Gardners' Complete Manure	S. Wood	1106
Moro Phillips Fertilizer Co. Branch.		
Sweet Potato Phosphate	J. H. Richardson	1465
Preston Fertilizer Co. Branch.		
Tomato Guano	H. O. Newcomb	1150
Pioneer Fertilizer	H. I. Budd	1287
Lawn Dressing	"	1288

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.40	......	2.16	2.56	2.46	6.90	2.78	2.03	11.71	12.00	9.68	10.00	*2.63	2.00	$21 15	$25 00
1.18	......	1.91	3.09	3.28	5.18	2.82	0.88	8.88	10.00	8.00	7.00	*10.08	10.00	27 84	32 00
0.32	......	0.79	1.11	1.03	6.26	2.54	2.08	10.88	9.00	8.80	8.00	2.41	2.00	15 11	25 00
0.80	0.38	1.84	2.52	2.46	6.56	0.55	0.42	7.53	7.00	7.11	6.00	10.71	10.00	24 16	30 00
0.26	......	1.83	2.09	2.05	7.88	0.92	0.69	9.49	9.00	8.80	8.00	3.76	3.00	18 87	35 00
0.59	0.72	1.76	3.07	3.28	6.96	2.06	0.98	10.00	9.00	9.02	8.00	6.73	7.00	24 77	38 00
1.05	1.02	1.90	3.97	4.10	7.00	0.83	0.61	8.44	8.00	7.83	7.00	7.13	7.00	26 51	36 00
0.82	0.92	1.50	3.24	3.28	5.28	1.64	1.52	8.44	7.00	6.92	6.00	10.23	10.00	26 37	31 00
0.81	......	1.42	2.23	2.05	2.62	5.09	3.84	11.55	9.00	7.71	8.00	3.59	3.00	19 11	27 50
......	......	1.27	1.27	0.82	4.44	3.82	3.91	12.17	9.00	8.26	8.00	2.51	2.00	16 01	27 00
0.89	......	1.67	2.56	2.46	2.42	2.87	4.01	9.30	7.00	5.29	6.00	7.12	6.00	20 77	30 00
0.26	......	2.13	2.39	2.05	3.00	4.03	4.45	11.48	10.00	7.03	8.00	2.28	1.50	18 29	25 00
0.71	......	1.64	2.35	2.46	6.18	2.08	1.88	10.14	9.00	8.26	8.00	3.80	4.00	19 48	30 00
0.20	......	0.94	1.14	0.82	7.02	2.00	2.64	11.66	8.00	9.02	7.00	2.00	1.00	15 35	23 00
......	......	0.94	0.94	0.82	6.36	1.54	2.69	10.59	....	7.90	8.00	3.52	4.00	14 99	28 00
0.74	......	1.84	2.58	2.46	5.92	2.08	1.85	9.85	....	8.00	8.00	6.11	6.00	21 89	35 00
1.02	......	2.61	3.63	3.28	6.80	1.50	1.77	10.07	....	8.30	7.00	6.86	7.00	26 06	35 00
......	......	2.07	2.07	2.05	4.82	4.29	2.75	11.86	9.00	9.11	8.00	3.98	3.00	20 21	28 00
0.85	0.65	1.91	3.41	3.28	4.28	3.65	2.73	10.66	9.00	7.93	8.00	7.86	7.00	26 34	30 00
0.36	0.36	1.04	1.76	1.64	4.96	3.23	3.47	11.66	....	8.19	8.00	2.56	2.00	17 29	25 00
......	......	1.08	1.08	0.82	4.98	3.08	2.02	10.08	9.00	8.06	8.00	4.34	4.00	16 01	25 00
......	......	2.39	2.39	2.46	6.92	2.00	2.12	11.04	10.00	8.92	9.00	4.79	2.00	21 49	25 00
0.50	......	1.57	2.07	2.05	6.84	2.08	1.82	10.69	9.00	8.87	8.00	6.07	6.00	21 18	28 00
......	1.40	2.03	3.43	3.28	5.50	2.13	1.69	9.32	7.00	7.63	6.00	9.37	10.00	27 40	31 00
0.32	......	1.36	1.68	1.64	6.62	1.70	1.37	9.69	9.00	8.32	8.00	10.77	10.00	23 28	29 00
0.47	......	1.17	1.64	1.64	4.18	4.16	1.95	10.29	....	8.34	6.00	3.43	3.00	17 09	25 00
0.34	......	0.62	0.96	1.03	5.92	2.08	1.39	9.39	9.00	8.00	8.00	2.31	2.00	13 45	22 00
1.48	......	1.63	3.11	3.28	4.44	2.48	1.65	8.57	....	6.92	8.00	9.23	7.00	24 78	36 00

*Potash largely, if not entirely, in form of sulfate. See page 88.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND	SAMPLER.	Station Number.
American Agricultural Chem. Co.—(Cont.)		
The Quinnipiac Co. Branch.		
Climax Phosphate	W. Pettit	1658
Complete Potato Manure	"	1659
Mohawk Fertilizer	"	1660
Market Garden	"	1661
Read Fertilizer Co. Branch.		
Vegetable and Vine Phosphate	H. I. Budd	1289
Farmers' Friend Superphosphate	"	1290
Leader Blood and Bone	A. Dilts	1423
Potato Special	W. O. Ward	1344
Sharpless & Carpenter Branch.		
Dissolved Bone Phosphate	H. O. Newcomb	1012
No. 1 Bone Phosphate	J. H. Richardson	1469
Gilt Edge Potato and Tobacco Manure	H. I. Budd	1623
Potato, Corn and Truck	"	1624
Susquehanna Fertilizer Co. Branch.		
Potato Phosphate	W. O. Ward	1345
Tygert-Allen Fertilizer Co. Branch.		
Superior Ground Fish Guano	H. O. Newcomb	1014
Star Bone Phosphate	C. Kraus	1575
Popular Phosphate	S. Wood	1091
Potato Manure	"	1092
Special Potato	J. C. Griscom	1115
Sweet Potato Manure	"	1116
Soluble Marine Guano	"	1118
Williams & Clark Fertilizer Co. Branch.		
Good Grower Potato Phosphate	H. S. Van Nuys	1188
Potato Phosphate	"	1185
Royal Bone Phosphate	D. N. Warbasse	1458
Prolific Crop Producer	A. Dilts	1429
Americus Universal Ammoniated Dissolved Bone	J. Heck	1225
Armour Fertilizing Works, Chicago, Ill.		
All Soluble	S. Wood	1098
Manure Substitute	J. J. Mitchell	1507
High Grade Potato	J. Heck	1200
Fruit and Root Fertilizer	A. Dilts	1455
Ammoniated Bone with Potash	"	1408
Cortelyou's Wheat and Rye Special	H. S. Van Nuys	1350

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.		Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
......	......	1.06	1.06	1.03	4.70	2.85	2.09	9.64	....	7.55	8.00	2.16	2.00	$18 62	$18 00
0.63	......	1.61	2.24	2.46	5.04	1.25	1.21	7.50	....	6.29	6.00	5.91	6.00	18 71	24 00
......	......	0.86	0.86	0.82	4.02	2.06	1.55	7.63	....	6.08	7.00	1.07	1.00	10 36	16 50
1.20	......	1.77	2.97	3.28	4.90	8.16	2.07	10.13	....	8.06	8.00	6.76	7.00	25 66	25 00
0.39	......	1.76	2.15	2.05	6.64	2.55	1.63	10.82	9.00	9.19	8.00	6.53	6.00	21 94	28 00
0.34	0.24	1.71	2.29	2.05	6.76	2.33	1.27	10.36	9.00	9.09	8.00	3.42	3.00	19 72	25 00
......	......	1.21	1.21	0.82	2.68	4.55	3.50	10.73	8.00	7.23	7.00	1.59	1.00	13 85	22 00
......	......	1.41	1.41	0.82	2.50	1.56	1.55	5.61	5.00	4.06	4.00	7.50	8.00	15 57	25 00
0.47	......	1.60	2.07	2.05	6.56	2.45	1.57	10.58	....	9.01	6.00	6.52	6.00	21 62	28 00
......	0.28	1.34	1.62	1.64	4.14	3.61	2.59	10.34	10.00	7.75	8.00	2.23	2.00	15 90	28 00
0.32	0.20	1.20	1.72	1.64	6.14	1.86	1.66	9.66	9.00	8.00	8.00	10.36	10.00	22 87	27 00
0.20	0.22	0.99	1.41	1.23	3.68	2.78	1.55	7.96	7.00	6.41	6.00	5.31	5.00	16 00	24 00
......	......	1.62	1.62	1.64	5.20	2.50	2.01	9.71	9.00	7.70	8.00	5.88	5.00	18 67	27 00
0.43	0.25	1.18	1.86	1.83	2.56	3.07	1.60	7.23	....	5.63	5.00	1.81	1.00	13 62	22 00
0.70	......	1.45	2.15	2.05	5.12	3.29	1.80	10.21	9.00	8.41	8.00	3.41	3.00	18 63	25 00
......	0.21	0.71	0.92	0.82	5.1[illegible]	2.68	1.43	9.21	9.00	7.78	8.00	2.12	2.00	15 11	25 00
......	1.49	1.82	3.31	3.28	5.10	2.48	1.99	9.57	7.00	7.58	6.00	9.52	10.00	27 21	30 00
0.47	0.23	1.49	2.19	2.05	5.94	2.72	1.75	10.41	....	8.66	8.00	5.72	6.00	21 07	27 00
0.46	......	1.42	1.88	1.64	5.94	2.88	1.88	10.20	10.00	8.32	8.00	10.23	10.00	23 60	28 00
1.30	0.23	1 84	3.37	3.28	5.12	3.25	1.83	10.20	....	8.37	8.00	7.24	7.00	25 54	33 00
......	......	1.43	1.43	1.23	4.16	3.64	3.24	11.04	8.00	7.80	6.00	6.99	5.00	19 62	27 00
0.80	......	1.78	2.58	2.46	2.06	4.11	3.04	9.21	7.00	6.17	6.00	*7.45	6.00	21 86	27 00
......	......	1.35	1.35	1.03	3.94	4.06	2.55	10.52	9.00	7.97	8.00	2.26	2.00	15 23	25 00
......	......	1.14	1.14	0.82	5.78	1.48	1.47	8.68	8.00	7.21	7.00	1.37	1.00	12 61	21 00
......	......	1.96	1.96	1.64	4.58	3.61	4.31	12.50	9.00	8.19	8.00	2.34	2.00	18 17	24 00
0.76	......	2.50	3.26	2.87	6.22	3.02	0.72	9.96	....	9.24	8.00	*5.63	4.00	25 29	32 00
......	......	4.55	4.55	3.28	4.08	2.98	1.08	8.14	....	7.06	6.00	6.25	4.00	26 51	34 00
......	......	1.61	1.61	1.64	5.06	3.93	3.07	12.06	10.00	8.99	8.00	7.55	10.00	21 79	30 00
......	......	1.89	1.89	1.64	4.20	3.79	2.49	10.48	10.00	7.99	8.00	5.85	5.00	20 01	25 00
0.42	......	1.92	2.34	2.46	3.88	3.64	1.67	9.19	8.00	7.52	6.00	2.90	2.00	17 98	25 00
......	......	1.67	1.67	1.64	7.22	2.75	1.21	11.18	....	9.97	8.00	2.08	2.00	17 56	20 00

* Potash largely, if not entirely, in form of sulfate. See page 38.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
Armour Fertilizing Works.—(Cont.)		
Grain Grower	J. M. Dalrymple	1855
Corn, Wheat and Oats Special	"	1856
Warren Atkinson, Mullica Hill, N. J.		
High Grade Po ato Fertilizer	S. Wood	1095
Special Sweet Potato	J. C. Griscom	1120
Potato and General Truck	"	1121
Special Early Tomato Grower	"	1122
Cabbage and Tomato	"	1123
James H. Baird, Marlboro, N. J.		
Potato Manure	H. D. Hance	1629
Asparagus Manure	"	1630
Grass Mixture	"	1631
Baugh and Sons Co., Philadelphia, Pa.		
Animal Bone and Potash	H. I. Budd	1276
$25 Phosphate	"	1277
General Crop Grower for All Crops	"	1278
The Berg Co., Philadelphia, Pa.		
Electric $35 Potato Manure	C. Kraus	1560
Cyclone Bone Manure	"	1561
Standard Bone Manure	J. M. Dalrymple	1476
Special $25 Bone Manure	"	1475
Lymph Guano	H. I. Budd	1611
Berger Bros., Easton, Pa.		
Peerless Phosphate	W. O. Ward	1824
Potato and Truck	"	1825
Bowker Fertilizer Co., Boston, Mass.		
Hill and Drill	H. D. Hance	1638
Potato and Vegetable Manure	J. M. Dalrymple	1478
Bone and Potash, Square Brand	"	1477
Sweet Potato and Truck	H. O. Newcomb	1086
Market Garden	"	1142
Farm and Garden Phosphate	W. O. Ward	1828
Early Potato Manure	J. Heck	1204
Potato and Vegetable Phosphate	"	1206
Stockbridge Corn Manure	"	1209
Stockbridge Potato Manure	H. I. Budd	1279
Stockbridge Top Dressing	F. E. Woodruff	1879
Lawn and Garden Dressing	"	1880
Fish and Potash, Square Brand	"	1881

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
......	......	1.73	1.73	1.64	5.76	2.61	2.07	10.44	10.00	8.37	8.00	1.94	2.00	$16 39	$23 00
......	......	0.77	0.77	0.82	5.70	2.64	1.76	10.10	9.00	8.34	8.00	1.58	1.00	12 84	21 00
0.49	1.09	2.11	3.69	3.28	7.90	2.98	1.01	11.84	11.00	10.83	8.00	6.96	7.00	28 87	32 00
0.10	......	1.54	1.94	1.64	5.18	3.62	2.90	11.70	10.00	8.80	8.00	10.52	10.00	24 95	28 00
0.79	......	2.02	2.81	2.46	7.60	2.21	1.94	11.75	10.00	9.81	7.00	7.42	7.00	25 57	28 00
2.58	0.23	2.34	5.15	5.33	7.26	1.60	0.66	9.52	8.00	8.86	7.00	5.35	4.00	29 14	32 00
0.64	......	2.17	2.81	2.46	4.88	3.78	2.93	11.59	9.00	8.66	7.00	5.65	5.00	23 36	26 00
1.02	1.47	0.88	3.37	3.28	4.74	3.91	1.75	10.40	....	8.65	8.00	9.89	10.00	28 29	30 00
3.08	0.32	3.49	6.89	6.56	1.14	7.06	1.42	9.62	....	8.20	5.00	3.61	2.00	32 69	32 50
6.86	......	2.26	9.12	8.20	1.46	4.50	0.60	6.56	....	5.96	3.00	5.40	5.00	37 23	35 00
......	......	1.92	1.92	1.64	5.20	3.23	2.23	10.66	....	8.43	8.00	2.23	2.00	17 36	23 00
......	......	1.71	1.71	1.64	4.44	4.58	2.45	11.47	....	9.02	8.00	1.16	1.00	16 46	25 00
......	......	1.13	1.13	0.82	5.24	3.44	2.24	10.92	....	8.68	8.00	1.42	1.00	14 41	20 00
0.33	......	1.69	2.02	2.46	4.02	6.11	4.64	14.77	9.00	10.13	7.00	7.72	8.00	24 88	32 72
......	......	2.04	2.04	2.46	3.50	4.45	2.87	10.82	9.00	7.95	7.00	2.69	3.00	17 92	30 00
0.20	......	1.64	1.84	2.46	4.16	4.68	3.67	12.51	10.00	8.84	8.00	5.07	6.00	20 43	28 00
......	......	1.59	1.59	1.64	3.24	5.40	3.79	12.43	9.00	8.64	7.00	2.12	2.00	17 05	24 00
0.66	......	1.71	2.37	2.87	3.82	5.49	3.42	12.73	9.00	9.31	7.00	8.60	8.00	25 31	33 00
......	......	1.10	1.10	0.82	3.68	4.76	1.38	9.82	10.00	8.44	8.00	2.58	2.00	14 70	20 00
1.38	......	1.86	3.24	3.69	5.38	3.05	1.58	10.01	10.00	8.43	8.00	6.03	6.00	24 00	32 50
0.81	......	1.77	2.58	2.46	5.54	4.00	1.70	11.24	12.00	9.54	9.00	2.33	2.00	20 13	31 00
......	......	2.37	2.37	2.25	5.48	2.82	1.86	10.16	11.00	8.30	9.00	3.96	4.00	19 98	30 00
......	......	1.54	1.54	1.64	1.94	4.48	6.75	13.17	10.00	6.42	6.00	1.95	2.00	15 71	24 00
0.42	......	1.20	1.62	1.64	4.02	2.61	1.90	8.53	....	6.63	6.00	7.90	8.00	19 13	28 00
0.72	......	1.62	2.34	2.46	3.82	2.86	2.78	9.41	7.00	6.68	6.00	10.63	10.00	24 00	35 00
0.26	......	1.42	1.68	1.64	6.88	4.11	2.48	13.47	11.00	10.90	9.00	2.13	2.00	19 06	25 00
1.41	......	1.82	3.23	3.28	6.08	1.91	1.78	9.77	9.00	7.99	7.00	7.17	7.00	24 57	33 00
0.26	......	1.56	1.82	1.50	5.52	2.25	2.75	10.52	11.00	7.77	9.00	2.09	2.00	16 36	25 00
1.14	......	2.09	3.23	3.28	6.62	1.70	0.99	9.31	9.00	8.32	7.00	7.15	7.00	24 68	36 00
1.60	......	1.51	3.11	3.28	6.84	2.10	1.80	10.74	8.00	8.94	6.00	*10.41	10.00	29 38	32 00
2.52	......	2.29	4.81	4.92	3.80	3.07	1.75	8.62	6.00	6.87	5.00	6.37	6.00	27 38	35 00
3.52	......	0.53	4.05	3.28	4.38	1.45	1.08	6.91	8.00	5.83	6.00	5.32	5.00	22 35	55 00
......	......	2.45	2.45	2.25	1.22	4.13	2.23	7.58	8.00	5.35	....	4.46	4.00	17 87	30 00

* Potash largely, if not entirely, in form of sulfate. See page 38.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
Bowker Fertilizer Co.—(Cont.)		
Bone and Wood Ash Fertilizer	S. Wood	1097
Sure Crop Phosphate	A. Dilts	1458
Potash-Bone	W. O. Ward	1830
Bradley & Green Fertilizer Co., Philadelphia, Pa.		
Special Potato Manure	H. I. Budd	1060
Wm. B. Brown, Cedarville, N. J.		
Special Potato	H. O. Newcomb	1401
E. Frank Coe Co., New York City.		
Excelsior Potato Fertilizer	F. E. Woodruff	1887
Excelsior Guano Red Brand	H. S. Van Nuys	1169
High-Grade Potato	J. J. Mitchell	1522
Original Ammoniated Dissolved Bone Phosphate	J. M. Dalrymple	1228
Extra Special Potato Fertilizer	W. T. Woerner	1800
New England Special Corn Fertilizer	J. M. Dalrymple	1248
Ground Bone and Potash	A. Dilts	1409
Special for All Crops	"	1410
Alkaline Bone Phosphate	H. I. Budd	1062
High-Grade Fish and Potash	"	1616
Peach Tree, Grape and Vine	H. D. Hance	1641
John S. Collins & Son, Moorestown, N. J.		
High-Grade Fertilizer for Potatoes and General Use	H. I. Budd	1063
Cabbage and Tomato Fertilizer	"	1065
Fish Guano	"	1068
Collins & Pancoast, Merchantville, N. J.		
Cabbage and Tomato Fertilizer	S. Wood	1099
High-Grade Fertilizer for Potatoes	"	1100
Fish Guano	"	1102
I. S. Curtis, Frenchtown, N. J.		
High-Grade Bone Phosphate	A. Dilts	1411
$20-Phosphate	"	1412
Davis, Colson & Co., Woodstown, N. J.		
High-Grade Potato and Truck	W. Pettit	1251
High-Grade Bone Phosphate	"	1252
Special Corn Mixture	"	1253
Potato and Tomato Fertilizer	"	1254
B. F. Demarris & Son, Cedarville, N. J.		
Special Berry Manure	H. O. Newcomb	1039
Special Superphosphate	"	1041

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.40	0.49	0.67	1.56	1.50	....	5.37	5.17	10.54	8.00	5.37	6.00	*2.24	2.00	$14 56	$26 00
......	......	0.86	0.86	0.75	2.44	5.23	3.93	11.60	11.00	7.67	9.00	2.07	2.00	13 75	20 00
0.20	......	0.72	0.92	0.82	2.60	3.31	2.54	8.45	8.00	5.91	6.00	2.12	2.00	11 60	20 00
......	0.25	1.94	2.19	2.46	4.32	3.92	3.15	11.39	....	8.24	8.00	8.41	8.00	23 69	27 00
0.79	......	1.53	2.32	2.46	5.04	3.22	1.46	9.72	10.00	8.26	....	9.29	7.00	23 85	30 00
......	0.84	1.61	2.45	2.46	5.30	0.99	2.69	8.98	8.00	6.29	7.00	*8.20	8.00	23 49	37 00
......	1.04	2.17	3.21	3.28	7.30	1.06	2.41	10.77	10.50	8.36	9.00	*7.80	6.00	27 49	36 00
......	0.40	1.94	2.34	2.46	6.14	1.18	3.58	10.80	9.00	7.27	7.00	*8.07	6.50	24 28	34 00
......	......	1.70	1.70	1.23	7.22	1.18	3.75	12.10	....	8.35	10.00	*2.36	2.25	17 65	25 00
......	0.58	1.19	1.72	1.64	7.06	1.66	2.97	11.69	9.50	8.72	8.00	*8.06	10.00	23 53	32 00
......	......	1.18	1.18	0.82	4.48	2.66	3.99	11.13	8.50	7.14	7.00	*3.55	3.00	16 07	21 00
......	0.29	2.34	2.63	1.64	....	6.63	7.43	14.06	14.00	6.63	11.00	2.75	2.00	20 39	30 00
......	......	1.22	1.22	1.23	7.00	1.27	3.85	12.12	10.00	8.27	8.50	*2.18	2.00	15 89	22 00
......	......	1.54	1.54	1.23	6.76	1.52	3.60	11.88	10.00	8.28	8.50	*3.10	2.50	17 75	25 00
......	......	2.49	2.49	2.46	2.66	3.31	6.34	12.31	10.00	5.97	7.00	*2.43	2.00	18 91	30 00
......	0.23	1.30	1.53	1.23	6.26	1.37	2.87	10.50	8.00	7.63	....	*5.17	5.00	18 87	27 00
0.77	......	1.88	2.65	2.46	6.84	2.15	0.87	9.86	....	8.99	8.00	*11.16	10.00	28 68	28 00
1.48	......	1.69	3.17	3.28	2.16	5.61	1.72	9.49	....	7.77	7.00	*5.93	5.00	23 40	27 00
0.77	0.24	1.38	2.39	2.46	6.22	2.40	1.69	10.31	....	8.62	8.00	4.21	4.00	20 25	26 00
0.85	......	2.32	3.17	3.28	2.44	5.51	3.63	11.58	....	7.95	7.00	*6.36	5.00	25 39	28 00
1.12	......	1.81	2.93	2.46	5.82	3.02	1.05	9.89	....	8.84	8.00	*10.24	10.00	27 34	28 00
1.12	......	2.79	3.91	2.46	4.60	4.02	1.87	10.49	....	8.62	8.00	3.71	4.00	24 59	25 00
1.27	......	1.61	2.88	1.64	5.90	1.80	1.58	9.23	....	7.70	8.00	4.62	3.00	20 97	26 00
0.56	......	1.10	1.66	0.82	4.60	2.99	2.18	9.72	....	7.59	6.00	4.96	2.00	17 75	20 00
0.69	0.21	2.42	3.32	3.69	5.50	1.88	2.89	10.27	....	7.38	8.00	7.41	7.00	25 20	29 00
0.58	......	1.94	2.52	2.46	8.44	0.80	0.94	10.18	....	9.24	9.00	7.11	5.00	23 49	28 00
1.01	......	1.91	2.92	2.87	7.44	0.96	1.99	10.39	....	8.40	7.00	4.86	3.00	22 27	22 00
0.82	......	2.37	3.19	2.46	4.28	3.13	2.62	10.03	....	7.41	8.00	6.76	5.00	24 09	24 00
4.16	......	0.41	4.57	3.69	1.58	4.74	1.69	8.01	....	6.32	6.00	4.04	4.00	23 39	30 00
......	......	1.49	1.49	0.82	11.60	1.23	0.90	13 78	....	12.88	10.00	*3.13	1.00	21 14	21 00

* Potash largely, if not entirely, in form of sulfate. See page 88.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
B. F. Demarris & Son.—(Cont.)		
Potato Fertilizer	H. O. Newcomb	1042
Complete No. 1 Bone Phosphate	"	1043
J. H. Denise, Freehold, N. J.		
Grass Manure	H. D. Hance	1642
Special Potato	"	1643
Garden and Truck	"	1644
High-Grade Potato	"	1645
Corn Phosphate	"	1646
H. W. Doughten, Moorestown, N. J.		
Special Potato Manure	H. I. Budd	1070
Dried and Ground Fish Guano	"	1071
Sure Shot Superphosphate	"	1072
Runyon Field, Bound Brook, N. J.		
Cabbage Manure	H. S. Van Nuys	1166
Potato Manure	"	1184
J. C. Fifield Sons & Co., Bakersville, N. J.		
Special Potato and Cabbage	H. I. Budd	1283
Special Sweet Potato	J. C. Griscom	1125
Fish and Potash	C. Kraus	1544
Fithian & Pennell, Bridgeton, N. J.		
Complete Phosphate	H. O. Newcomb	1145
Geo. B. Forrester, New York City.		
Irish Potato Manure	F. E. Woodruff	1400
W. O. Garrison, Bridgeton, N. J.		
Gold Dust	H. O. Newcomb	1044
Fish Guano	"	1046
Pride of Cumberland	"	1048
Farmers' Pride	"	1049
XX Brand	J. H. Richardson	1474
Truckers' Pride	"	1461
J. C. Griscom, Woodbury, N. J.		
King Crab Compound	W. C. Smallwood	1127
Wyckoff Hendrickson, Allentown, N. J.		
High-Grade Potato Manure	J. M. Dalrymple	1285
Special Potato Manure	"	1287
Corn Manure	"	1359
S. M. Hess & Bro., Philadelphia, Pa.		
Potato and Truck Manure	F. E. Woodruff	1390
Keystone Bone Phosphate	"	1389

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
......	0.77	1.61	2.38	1.64	6.14	2.94	1.78	10.81	....	9.08	9.00	7.66	6.00	$23 97	$28 00
......	0.79	1.64	2.43	1.64	8.96	1.00	0.81	10.77	....	9.96	9.50	5.07	2.00	22 45	24 00
7.37	......	0.64	8.01	7.79	3 00	4.55	1.36	8.91	....	7.55	6.00	3.63	2.50	33 87	34 00
2.03	......	1.85	3.88	3.69	4.68	3.74	1.76	10.18	....	8.42	8.00	8.66	8.50	28 08	29 50
2.76	......	1.80	4.56	4.10	3.62	4.75	2.67	11.04	....	8.37	9.00	4.44	5.00	26 70	29 00
1.60	......	2.16	3.76	3.69	5.08	2.85	1.74	9.67	....	7.93	8.50	10.27	10.00	28 75	30 00
0.44	......	2.24	2.68	2.46	5.54	3.56	3.53	12.63	....	9.10	9.00	5.93	5.00	23 95	25 00
......	1.76	0.87	2.63	2.46	7.10	2.64	1.97	11.71	....	9.74	10.00	*7.38	7.00	25 73	29 00
......	......	3.58	3.58	3.69	3.86	1.74	1.55	7.15	....	5.60	5.85	5.09	3.00	22 01	28 00
0.85	.....	1.85	2.70	2.87	7.96	2.42	2.51	12.89	11.00	10.38	10.00	3.01	3.00	22 24	27 00
1.31	0.21	2.83	3.85	4.10	0.16	8.32	4.16	12.64	....	8.48	8.00	7.67	7.00	28 48	31 00
1.02	0.92	1.29	3.23	3.28	0.02	4.75	1.84	6.61	....	4.77	8.00	8.90	7.00	23 11	28 00
......	......	2.49	2.49	2.46	2.90	4.27	2.87	10.04	....	7.17	7.00	7.70	7.00	22 84	33 00
......	......	2.11	2.11	2.05	1.54	5 19	2.70	9.43	....	6.73	5.00	9.74	10.00	22 84	35 00
......	......	2.49	2.49	1.64	4.28	3.73	1.92	9.93	....	8.01	7.00	4.20	4.00	20 32	29 00
0.26	......	1.52	1.78	1.64	6.88	1.52	2.10	10.50	....	8.40	8.00	2.09	2.00	16 61	23 50
1.85	1.89	0.03	3.77	3.69	5.20	1.60	1.81	8.61	....	6.80	5.50	9.43	10 00	27 06	33 00
0.26	......	0.75	1.01	0.82	4.56	4.31	1.77	10.64	10.00	8.87	9.00	3.03	2.50	15 29	17 00
1.24	......	1.55	2.79	4.10	5.92	2.44	1.76	10.12	....	8.36	8.00	6.63	8.00	23 12	30 00
1.10	......	0.73	1.83	2.05	3.28	6.06	3.84	13.18	....	9.34	9.00	3.26	3.00	19 07	25 00
0.75	......	0.83	1.58	1.64	5.00	5.01	3.17	13.18	....	10.01	9.00	1.93	2.00	17 68	25 00
......	......	1.46	1.46	1.23	3.52	3.20	2.51	9.23	7.00	6.72	6.00	2.27	2.50	14 32	20 00
0.81	......	3.11	3.92	4.10	5.60	1.97	1.07	8.64	....	7.57	8.00	7.37	7.00	26 48	33 00
0.79	1.24	1.90	3.93	4.10	6.16	2.56	0.79	9.51	10.00	8.72	8.00	5.14	5.00	25 79	31 00
1.61	0.21	2.09	3.91	2.46	3.52	4.58	1.00	9.10	....	8.10	8.00	10.64	10.00	29 43	32 00
1.17	......	2.02	3.19	1.64	3.62	4.22	1.57	9.41	....	7.84	7.00	10.66	10.00	27 27	29 00
......	......	1.80	1.80	1.64	7.18	4.04	3.83	15.05	....	11.22	8.00	4.88	4.00	22 66	25 00
0.80	......	1.87	2.67	2.46	6.40	1.94	1.98	10.32	....	8.34	8.00	6.70	6.00	23 04	35 00
......	......	0.92	0.92	0.82	5.84	2 24	2.60	10.68	10.00	8.08	8.00	1.64	1.00	13 45	28 00

* **Potash largely, if not entirely, in form of sulfate. See page 38.**

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
S. M. Hess & Bro.—(Cont.)		
Special Potato	W. T. Woerner	1302
Special Corn	H. I. Budd	1618
Ira Hill, Copper Hill, N. J.		
Pure Bone Phosphate	A. Dilts	1413
Potato Phosphate	"	1414
Hill & Co., Flemington, N. J.		
No. 2 Bone Phosphate	A. Dilts	1416
Standard Bone Fertilizer	"	1417
10 Per Cent. Potato Phosphate	"	1418
Hires & Co., Quinton, N. J.		
Special Wheat and Oats Phosphate	W. Pettit	1256
Special Potato Manure	"	1258
Special Potato and Tomato Phosphate	"	1259
Standard Bone Phosphate	"	1260
International Seed Co., Rochester, N. Y.		
Potato and Truck Manure	S. Wood	1104
Grass and Grain	J. J. Mitchell	1524
Keystone Chemical Fertilizer Co., Philadelphia, Pa.		
Economizer Fertilizer	J. H. Richardson	1462
Special Potato	"	1463
Lister's Agricultural Chemical Works, Newark, N. J.		
Special Corn and Potato	H. O. Newcomb	1146
Potato Manure	J. B. Ward	1601
Potato No. 2	H. S. Van Nuys	1175
Standard Pure Bone Superphosphate of Lime	J. M. Dalrymple	1239
Ammoniated Dissolved Bone Phosphate	"	1240
U. S. Superphosphate	F. E. Woodruff	1395
"G" Brand	A. Dilts	1419
Fruit and Vine	J. B. Ward	1603
The Mapes Formula & Peruvian Guano Co., N. Y. City.		
Cereal Brand	A. Dilts	1421
Economical Potato Manure	J. Heck	1216
Corn Manure	J. B. Ward	1606
Lawn Top Dressing	"	1605
Complete Manure, "A" Brand	J. J. Mitchell	1526
Complete Manure for General Use	"	1528
Potato Manure	H. I. Budd	1284
General Crop Brand	J. M. Dalrymple	1483
Complete 10 Per Cent. Potash	D. N. Warbasse	1436
" " " Special	"	1440

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen. From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.88	......	2.35	3.23	3.28	7.12	1.50	1.62	10.24	....	8.62	8.00	6.92	7.00	$25 15	$33 00
......	......	1.15	1.15	0.82	4.66	3.16	1.96	9.78	....	7.82	8.00	2.27	2.00	14 21	25 00
......	......	2.26	2.26	2.05	1.40	5.31	2.50	9.21	10.50	6.71	....	3.50	2.50	17 92	23 00
......	......	2.70	2.70	3.28	1.98	5.52	2.49	9.99	10.50	7.50	....	8.73	9.00	24 56	28 00
......	......	1.32	1.32	0.82	1.76	5.19	4.47	11.42	....	6.95	8.00	2.75	2.00	15 30	19 00
......	......	1.45	1.45	2.05	4.52	3.44	2.56	10.52	....	7.96	8.00	2.24	2.50	15 52	22 00
0.45	0.45	1.10	2.00	1.64	3.08	4.51	3.53	11.12	....	7.59	8.00	9.71	10.00	23 53	27 00
......	......	0.90	0.90	0.82	4.16	4.12	2.52	10.80	....	8.28	8.00	2.51	2.00	14 30	16 00
......	......	2.90	2.90	2.46	5.22	2.78	1.97	9.97	....	8.00	7.00	*9.72	10.00	26 74	29 00
......	......	2.36	2.36	2.46	7.80	0.51	1.20	9.51	....	8.31	8.00	5.40	5.00	20 93	23 00
......	......	1.84	1.84	1.64	7.80	1.75	1.14	10.69	....	9.55	9.00	3.71	3.00	19 05	20 00
0.41	......	0.91	1.32	1.23	5.06	2.79	2.11	9.96	9.00	7.85	8.00	7.29	7.00	18 94	28 00
......	......	2.01	2.01	1.64	6.30	3.17	4.13	13.60	11.00	9.47	10.00	2.06	2.00	19 30	25 00
0.78	......	0.99	1.77	1.76	5.64	2.36	1.37	9.37	9.50	8.00	8.50	*4.92	2.60	18 53	25 00
0.33	......	1.04	1.37	1.64	2.68	3.90	2.32	8.90	9.00	6.58	8.00	2.29	5.00	13 71	30 00
......	......	1.74	1.74	1.64	4.18	5.52	2.95	12.65	9.00	9.70	8.00	3.16	3.00	19 14	25 00
0.21	1.45	1.57	3.23	3.28	6.60	2.24	2.22	11.06	9.00	8.84	8.00	6.94	7.00	26 03	36 00
......	1.20	0.93	2.13	1.64	8.04	1.70	2.33	12.07	11.00	9.74	10.00	*5.89	4.00	23 06	26 00
......	0.97	1.48	2.45	2.46	7.72	2.88	3.49	14.09	11.00	10.60	9.00	2.29	2.00	21 85	25 00
......	0.22	1.77	1.99	1.64	6.10	3.87	2.90	12.87	9.00	9.97	8.00	1.92	1.00	19 16	22 00
......	0.21	0.99	1.20	1.03	5.46	3.03	2.46	10.95	9.00	8.49	8.00	2.78	2.00	15 69	20 25
......	......	0.96	0.96	0.82	5.76	2.43	2.48	10.67	10.00	8.19	8.00	4.09	4.00	15 72	19 00
......	0.23	2.60	2.83	1.64	1.02	7.89	3.30	12.21	....	8.91	8.00	6.73	7.00	25 03	32 00
1.07	......	1.32	2.39	1.64	1.70	6.02	0.53	8.25	8.00	7.72	6.00	3.61	3.00	18 22	28 00
1.89	......	1.32	3.21	3.28	2.00	5.06	0.71	7.77	6.00	7.06	4.00	*9.14	8.00	25 99	35 00
0.90	......	1.55	2.45	2.46	0.70	8.89	1.65	11.24	10.00	9.59	8.00	5.54	6.00	22 40	35 00
1.80	......	0.45	2.25	2.46	2.04	2.32	0.16	4.52	....	4.36	3.50	3.55	2.50	13 96	24 00
0.58	......	2.13	2.71	2.46	3.18	8.10	1.77	13.05	12.00	11.28	10.00	3.05	2.50	23 02	35 00
0.95	......	2.61	3.56	3.28	3.08	6.60	1.65	11.33	10.00	9.68	8.00	4.85	4.00	25 55	39 00
1.77	0.25	1.57	3.59	3.69	2.66	6.24	1.52	10.42	8.00	8.90	8.00	*8.47	6.00	28 79	39 00
0.32	......	1.42	1.74	1.64	2.38	6.62	0.90	9.90	10.00	9.00	8.00	*2.62	2.00	17 42	25 00
0.41	......	2.18	2.59	2.05	1.20	4.19	0.79	6.18	5.00	5.39	3.00	10.22	10.00	22 53	33 00
1.12	......	1.29	2.41	2.46	2.90	5.81	0.55	9.26	6.00	8.71	5.00	8.38	10.00	23 32	33 00

*Potash largely, if not entirely, in form of sulfate. See page 38.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
Hugh McAuany, Philadelphia, Pa.		
Quaker City Poudrette	H. O. Newcomb	1006
Mixner & Mickel, Bridgeton, N. J.		
Special Mixture	H. O. Newcomb	1050
Top Dresser	"	1051
Complete	"	1052
High Grade	"	1053
Fish Mixture	"	1055
Monmouth Chemical Works, Shrewsbury, N. J.		
Potato Fertilizer	J. Heallier	1653
Albert Nelson & Co., Allentown, N. J.		
Quick and Lasting Fertilizer for All Crops	J. M. Dalrymple	1362
Corn, Truck and Tomato Fertilizer	C. Burgmiller	1582
Special Potato	H. I. Budd	1621
Grass and Grain Special	H. Stryker	1665
Corn Fertilizer	"	1666
High-Grade Superphosphate	"	1667
Wm. C. Newport & Co., Willow Grove, Pa.		
Gilt Edge Potato Manure	H. I. Budd	1077
Farmers' Ammoniated Bone Phosphate	J. M. Dalrymple	1364
Fish, Bone and Potash	H. I. Budd	1076
No. 1 for Potatoes, Corn and Truck	H. O. Newcomb	1010
Evans' Brand, Potato Manure	W. T. Woerner	1305
Grain and Grass Special	H. O. Newcomb	1403
Rectified Phosphate	H. I. Budd	1073
High-Grade Potato Guano	"	1075
Potato Manure	"	1078
Dissolved Bone Phosphate	W. T. Woerner	1307
Potato and Truck Manure	W. O. Ward	1335
James E. Otis, Tuckerton, N. J.		
Special for Potatoes	J. C. Griscom	1123
Menhaden Fish Guano	H. I. Budd	1236
S. L. Pancoast, Mullica Hill, N. J.		
Early Potato Grower	J. C. Griscom	1130
Early Truck	"	1131
Peterson & Smith, Woodstown, N. J.		
Special Corn Mixture	W. Pettit	1255
Special Potato Mixture	"	1261
Wheat and Oats Superphosphate	"	1262
Potato and Tomato Superphosphate	"	1263
Potato Superphosphate	"	1264

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen. From Nitrates.	Nitrogen. From Ammonia Salts.	Nitrogen. From Organic Matter.	Nitrogen. Total Found.	Nitrogen. Total Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Soluble in Ammonium Citrate.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.25	0.21	0.91	1.37	1.64	0.02	2.95	0.15	3.12	....	2.97	4.00	0.63	1.00	$7 87	$18 00
0.68	......	1.68	2.36	1.23	3.92	5.06	5.33	14.31	....	8.98	9.00	1.98	2.00	20 07	23 00
3.04	......	1.66	4.70	4.51	0.50	6.40	1.72	8.62	....	6.90	6.00	*10.64	9.50	30 87	33 00
0.34	.....	1.72	2.06	2.05	6.22	3.24	2.52	11.98	....	9.46	8.00	2.88	3.00	19 37	25 00
0.72	......	1.84	2.56	2.46	5.86	1.04	0.64	7.54	....	6.90	6.00	10.07	10.00	23 63	31 00
1.05	......	1.65	2.70	2.46	3.10	3.85	1.28	8.23	....	6.95	7.00	3.88	3.00	18 98	26 00
0.32	0.85	1.61	2.78	2.87	5.08	2.03	1.29	8.40	....	7.11	8.00	8.37	10.00	23 61	32 00
0.69	......	1.32	2.01	2.05	6.54	2.89	0.85	9.78	9.00	8.93	8.00	12.94	12.00	26 40	27 00
0.48	0.90	1.19	2.57	2.46	5.86	2.78	1.95	10.59	9.00	8.64	8.00	4.82	4.00	21 64	26 00
0.75	......	1.30	2.05	2.05	6.24	2.68	1.03	9.95	9.00	8.92	8.00	10.34	10.00	24 37	27 00
0.25	0.24	0.98	1.47	1.23	5.74	3.08	3.00	11.82	10.00	8.82	8.00	2.04	2.00	16 38	21 50
0.39	0.36	1.04	1.79	1.64	5.42	2.12	3.13	10.67	9.00	7.54	8.00	2.30	2.00	16 36	22 00
0.29	0.26	1.39	1.94	1.64	3.94	4.79	2.89	11.62	10.00	8.73	8.00	2.89	3.00	18 47	23 00
0.76	......	1.48	2.24	1.85	4.90	2.46	2.05	9.41	9.00	7.36	7.00	8.92	10.00	22 64	30 00
......	......	0.82	0.82	0.82	2.28	6.05	2.62	10.95	9.00	8.33	7.00	3.45	4.00	14 93	22 00
0.85	.....	1.91	2.76	1.64	5.58	2.09	2.07	9.74	9.00	7.67	7.00	5.21	5.00	21 42	27 00
0.65	......	1.62	2.27	1.64	6.54	2.37	1.97	10.88	10.00	8.91	8.00	4.69	3.00	20 68	24 00
0.48	0.36	2.14	2.98	3.28	5.08	1.62	1.64	8.34	8.00	6.70	6.00	10.31	10.00	25 50	33 00
......	......	0.84	0.84	0.82	0.70	6.33	2.12	9.15	8.00	7.03	6.00	1.30	2.00	11 68	18 00
0.83	......	2.81	3.64	3.28	5.74	1.75	1.50	8.99	9.00	7.49	7.00	5.55	5.00	24 12	31 00
0.64	......	1.77	2.41	2.46	5.72	2.02	1.53	9.27	....	7.74	8.00	8.86	10.00	23 33	30 00
0.70	......	2.09	2.79	3.28	5.02	1.65	1.67	8.34	....	6.67	6.00	*11.11	10.00	25 65	32 00
1.25	......	0.65	1.90	1.64	4.94	1.75	2.33	9.02	....	6.69	7.00	8.03	8.00	20 02	30 00
0.21	......	0.55	0.76	0.82	4.62	1.54	8.78	14.94	....	6.16	6.00	8.59	7.00	19 37	27 00
......	......	2.86	2.86	2.46	4.26	2.94	2.21	9.41	....	7.20	7.00	8.62	10.00	24 56	28 00
......	......	3.02	3.02	3.28	3.86	4.49	3.53	11.88	....	8.35	7.00	4.72	5.00	23 44	28 00
0.49	......	2.61	3.10	3.28	5.44	2.22	1.31	8.97	....	7.66	7.50	7.60	7.50	24 36	29 00
1.37	......	2.49	3.86	3.69	5.72	1.83	1.48	9.03	....	7.55	7.50	5.39	5.00	24 53	28 00
1.19	......	1.41	2.60	2.46	4.24	2.17	1.61	8.02	....	6.41	6.00	3.84	3.00	18 15	24 00
1.16	......	1.30	2.46	2.46	2.80	3.45	2.32	8.57	....	6.25	6.00	10.97	10.00	23 91	27 50
......	......	1.14	1.14	0.82	3.54	4.36	2.15	10.05	....	7.90	8.00	3.10	2.00	15 05	17 00
0.63	......	1.87	2.50	2.46	4.24	3.62	3.43	11.29	....	7.86	8.00	5.30	5.00	21 48	25 00
0.41	......	1.27	1.68	1.64	4.48	2.31	3.11	9.90	....	6.79	6.00	9.64	10.00	21 43	26 00

* Potash largely, if not entirely, in form of sulfate. See page 38.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
Enos Richmond, Elmer, N. J.		
Special Corn	W. O. Ward	1340
Edward Rigg, Jr., Burlington, N. J.		
Special Potato Fertilizer	H. I. Budd	1291
Fish Guano	"	1292
M. F. Riley, Elmer, N. J.		
Potato Fertilizer	W. Pettit	1265
Special for Wheat and Grass	"	1266
Complete Fertilizer	"	1267
High-Grade Potato	"	1268
Ruckmann Bros., New Brunswick, N. J.		
Potato Fertilizer	W. T. Woerner	1813
Corn Fertilizer	"	1814
Truck Fertilizer	"	1815
Grain Fertilizer	"	1816
Russell Agricultural Chemical Co., Newark, N. J.		
Potato Manure	H. S. Van Nuys	1084
Special Corn Fertilizer	"	1085
Ten Per Cent. Potato	W. T. Woerner	1810
Champion Manure	J. M. Dalrymple	1249
Two Tons in One	"	1484
Ammoniated Dissolved Bone Phosphate	A. Dilts	1426
Harvest Queen Phosphate	"	1424
Climax	"	1425
Special Potato Fertilizer	W. O. Ward	1331
Saul & Johnson, Erma, N. J.		
Anti-Trust Potato and Tomato Grower	J. H. Richardson	1470
Sharpless & Bro., Camden, N. J.		
Ten Per Cent	S. Wood	1108
No. 1	"	1109
Special Potato Manure	"	1110
Extra High-Grade Manure	"	1111
M. L. Shoemaker & Co., Philadelphia, Pa.		
Swift-Sure Superphosphate for General Use	J. M. Dalrymple	1368
" " " " Potatoes	J. H. Richardson	1468
" " Special 10 Per Cent. Potato Fertilizer	H. I. Budd	1626
" " " " " " " " No. 2	H. S. Van Nuys	1181
" " New Jersey Special	C. Kraus	1548
Guano for Tomatoes, Truck and Corn	A. Dilts	1459
Echo Superphosphate	D. N. Warbasse	1443

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.					Available.		Potash.		Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
......	......	0.96	0.96	0.82	7.64	1.88	2.59	12.11	....	9.52	9.00	3.63	3.00	$16 71	$19 50
0.39	......	1.18	1.57	1.64	5.82	2.22	1.80	9.84	....	8.04	8.00	9.86	10.00	22 01	27 00
......	......	2.84	2.84	2.46	1.78	4.51	3.52	9.81	....	6.29	7.00	6.09	5.00	21 97	27 00
0.20	......	1.52	1.72	1.64	2.34	5.22	1.37	8.93	....	7.56	8.00	7.50	7.00	19 91	26 00
......	......	1.80	1.80	1.64	2.42	6.21	5.35	13.98	....	8.63	12.00	3.28	3.00	19 31	25 00
......	......	0.87	0.87	0.82	3.14	3.79	3.25	10.18	....	6.93	8.00	2.38	2.00	13 03	20 00
1.26	......	1.10	2.36	2.46	4.38	2.70	1.15	8.23	....	7.08	8.00	9.94	10.00	23 04	30 00
......	1.04	1.92	2.96	2.25	0.92	6.28	3.75	10.95	8.00	7.20	5.00	5.33	9.00	22 80	30 00
......	0.96	2.46	3.42	2.50	1.04	5.25	4.03	10.32	9.00	6.29	5.00	3.12	2.50	21 59	25 00
......	0.90	2.74	3.64	3.00	1.66	5.91	4.17	11.74	10.00	7.57	7.00	*5.04	5.00	25 64	28 00
......	0.87	2.45	3.32	2.50	1.90	5.71	3.46	11.07	9.00	7.61	5.00	4.35	5.00	23 40	24 00
1.63	0.28	1.31	3.22	3.70	2.96	3.69	4.62	11.27	8.50	6.65	7.50	6.59	7.00	23 77	28 00
......	0.28	1.92	2.20	1.65	2.50	3.85	4.76	11.11	9.00	6.35	8.00	2.82	3.00	17 71	20 00
......	......	1.29	1.29	1.64	4.72	3.72	3.11	11.55	9.00	8.44	8.00	9.91	10.00	22 23	30 00
......	......	0.72	0.72	0.82	5.02	2.86	3.82	11.70	9.00	7.88	8.00	2.07	2.00	13 47	21 00
......	......	2.13	2.13	2.05	4.78	5.47	8.94	19.19	20.00	10.25	....	3.35	2.50	23 50	24 00
......	......	1.86	1.86	1.80	5.34	2.77	2.71	10.82	11.00	8.11	9.00	1.80	1.50	16 67	24 00
......	......	1.13	1.13	1.23	5.08	4.15	2.37	11.60	11.50	9.23	9.50	2.24	2.00	15 70	23 00
......	......	0.86	0.86	0.82	4.84	3.40	4.06	12.30	9.00	8.24	8.00	2.02	2.00	14 33	20 00
......	......	1.27	1.27	1.64	5.20	3.38	3.72	12.30	9.00	8.58	8.00	3.04	3.00	16 71	25 00
......	0.22	2.17	2.39	2.46	....	9.75	3.12	12.87	....	9.75	7.00	7.76	7.00	25 26	28 00
1.81	......	3.26	5.07	3.20	5.53	1.21	1.06	7.83	....	6.77	4.00	5.97	4.00	27 77	45 00
0.69	......	1.89	2.58	1.64	6.70	2.28	1.89	10.87	....	8.98	8.00	5.38	3.00	22 29	24 00
0.44	1.01	1.29	2.74	2.05	5.78	2.63	1.27	9.68	....	8.41	7.00	8.25	10.00	24 62	28 00
0.60	......	2.24	2.84	3.28	5.46	1.94	1.87	9.27	....	7.40	6.00	8.99	10.00	24 64	30 00
1.15	......	1.71	2.86	2.46	6.60	3.83	3.82	14.25	14.00	10.43	9.00	6.44	4.00	26 12	32 00
0.87	......	1.64	2.51	2.46	6.50	4.13	3.12	13.75	11.00	10.63	8.00	7.40	6.50	25 86	32 00
1.44	......	2.24	3.68	3.28	3.44	4.29	2.32	10.05	....	7.73	6.00	10.87	10.00	29 10	28 00
0.72	......	1.55	2.27	2.05	4.82	4.24	3.49	12.55	....	9.06	8.00	10.74	10.00	26 57	32 00
......	......	1.53	1.53	1.03	5.00	5.65	3.90	14.55	....	10.65	8.00	2.25	2.00	19 02	24 00
0.64	......	1.59	2.23	1.64	3.26	6.08	4.22	13.56	....	9.34	8.00	5.64	5.00	22 70	26 00
......	......	1.64	1.64	1.23	4.82	5.44	4.88	15.14	9.00	10.26	7.00	2.06	1.50	19 21	24 00

*Potash largely, if not entirely, in form of sulfate. See page 88.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
M. L. Shoemaker & Co.—(Cont.)		
Good Enough Superphosphate	C. Kraus	1572
New Jersey Special for Oats	H. S. Van Nuys	1188
Lester Shurts, Neshanic, N. J.		
Standard Phosphate	H. S. Van Nuys	1849
L. W. Sickler, Glassboro, N. J.		
Special 10 Per Cent. Potato	J. C. Griscom	1182
Guano for Tomatoes	"	1133
Rufus W. Smith, Elmer, N. J.		
Ammoniated Consummate Fertilizer	W. Pettit	1269
Complete Bone Fertilizer	"	1270
High-Grade Trucker	"	1271
Somerset Chemical Co., Bound Brook, N. J.		
Excelsior Potato Manure	H. I. Budd	1079
Peerless Potato Manure	J. C. Griscom	1134
Sweet Potato and Tomato Manure	J. H. Richardson	1478
Royal Potato Grower	W. T. Woerner	1820
Reliance Phosphate	H. O. Newcomb	1155
Harvest Queen Phosphate	J. M. Dalrymple	1485
Special Potato Manure	H. O. Newcomb	1158
Stevens Bros., Cedarville, N. J.		
Special for Peas	H. O. Newcomb	1016
Henry Taylor, Vineland, N. J.		
No. 1 Special Potato Manure	H. O. Newcomb	1160
No. 2 " " "	"	1162
$25 Potato Manure	"	1161
The Taylor Provision Co., Trenton, N. J.		
High-Grade Corn and Truck	C. Kraus	1552
High-Grade Potato and Truck	C. H. Herbert	1508
Special Potato Fertilizer	"	1502
Corn Formula	J. M. Dalrymple	1585
A. D. B. Special Fertilizer	"	1871
I. P. Thomas & Son Co., Philadelphia, Pa.		
Special Sweet Potato Manure	J. C. Griscom	1136
Improved Superphosphate	A. Dilts	1427
Special High-Grade Potato Manure	J. M. Dalrymple	1288
Tip-Top Raw Bone Superphosphate	S. Wood	1594
Potato and Tomato Manure	H. O. Newcomb	1156
Vegetable Manure	D. N. Warbasse	1447

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.44	......	1.77	2.21	1.64	6.48	4.37	8.42	14.27	12.00	10.85	8.00	2.81	2.00	$21 50	$23 00
......	......	1.45	1.45	0.82	4.80	5.15	4.46	14.41	....	9.95	8.00	2.48	2.00	18 48	24 00
......	......	1.11	1.11	0.82	4.22	8.86	3.16	11.24	....	8.08	8.00	4.23	4.00	16 49	20 00
0.30	......	1.81	2.11	2.05	3.52	3.81	4.70	12.03	....	7.33	8.00	11.70	10.00	25 79	35 00
0.70	......	1.31	2.01	1.64	4.78	3.96	4.39	13.13	....	8.74	8.00	6.12	5.00	21 85	28 00
......	......	1.29	1.29	0.82	2.68	6.07	1.65	10.40	....	8.75	9.00	2.53	2.50	15 69	16 50
0.62	......	1 53	2.15	2.05	7.12	1.81	0.99	9.92	....	8.93	9.00	3.55	3.00	18 99	22 00
0.29	......	2.31	2.60	2.46	5.22	2.59	2.45	10.26	....	7.81	7.00	*7.33	7.00	23 74	26 00
0.49	0.33	1.12	1.94	2.46	....	5.8[illegible]	2.78	8.58	....	5.80	8.00	10.33	10.00	21 73	30 00
0.73	......	2.11	2.84	3.28	....	5.70	2.65	8.35	....	5.70	7.00	8.78	9.00	23 01	30 00
......	0.23	1.83	2.06	1.64	0.06	9.69	6.02	15.77	....	9.75	8.00	11.51	12.00	28 56	30 00
0.45	......	1.25	1.70	1.64	....	5.03	2.58	7.61	....	5.03	7.00	10.69	10.00	20 40	28 00
0.32	0.20	1.27	1.79	2.05	0.08	5.85	1.95	7.88	....	5.93	6.00	4.33	4.00	16 01	23 00
......	......	0.84	0.84	0.82	0.08	8.66	1.97	10.71	....	8.74	10.00	5.37	4.00	16 79	25 00
0.38	0.22	1.38	1.98	1.64	....	7.88	6.13	14.01	....	7.88	8.00	5.70	5.00	21 39	28 00
2.49	......	1.11	3.60	3.69	5.68	2.27	1.87	9.82	....	7.95	6.00	5.88	5.00	24 22	32 00
......	......	1.31	1.31	1.85	5.00	2.15	1.85	9.00	....	7.15	7.00	7.05	10.00	18 07	27 00
......	......	1.67	1.67	1.64	6.00	2.26	1.52	9.78	....	8.26	8.00	10.20	10.00	22 88	27 00
......	......	1.18	1.18	1.23	3.64	2.83	1.83	8.30	....	6.47	6.00	5.42	5.00	15 58	25 00
0.95	......	1.59	2.54	2.46	6.70	3.10	2.64	12.44	....	9.80	10.00	4.83	5.00	22 71	23 35
1.74	......	1.25	2.99	2.87	4.54	2.51	3.69	10.74	12.00	7.05	....	10.70	10.00	26 50	32 00
0.68	......	1.41	2.09	2.05	5.86	3.33	2.46	11.55	....	9.19	8.00	10.08	10.00	25 15	29 50
1.17	......	1.45	2.62	1.23	4.04	4.03	3.38	11.45	....	8.07	8.00	12.40	12.50	27 88	30 00
......	......	1.35	1.35	1.23	6.12	4.03	5.71	15.86	....	10.15	8.00	5.69	5.00	21 58	24 50
0.71	......	0.99	1.70	1.64	3.92	3.41	1.82	9.15	8.00	7.33	7.00	10.08	10.00	21 79	28 00
......	......	0.86	0.86	0.82	8.64	2.39	0.94	11.97	12.00	11.03	10.00	*1.14	1.00	15 30	23 50
0.76	......	1.61	2.37	2.46	4.04	2.99	1.60	8.63	10.00	7.03	8.00	9.16	10.00	22 74	30 00
0.60	......	1.91	2.51	2.46	4.72	3.77	1.87	10.36	10.00	8.49	8.00	4.47	4.00	20 83	31 00
0.88	......	0.96	1.84	1.64	5.40	4.30	1.61	11.31	....	9.70	9.00	6.31	6.00	21 23	25 00
0.64	......	1.12	1.76	1.64	3.36	6.15	2.24	11.75	....	9.51	9.00	2.42	4.00	17 84	30 00

* Potash largely, if not entirely, in form of sulfate. See page 38.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
I. P. Thomas & Son Co.—(Cont.)		
Fish Guano	J. M. Dalrymple	1878
Farmers' Choice Bone Phosphate	"	1495
Wheat and Grass Compound	"	1496
Trenton Bone Fertilizer Co., Trenton, N. J.		
High-Grade Potato Fertilizer	J. M. Dalrymple	1229
Corn Mixture	"	1246
Special Mixture	"	1874
$32 Potato Manure	"	1875
Excelsior	"	1486
Special Potato	D. N. Warbasse	1448
Special 10 Per Cent. Potato, No. 2	"	1451
Superphosphate	H. I. Budd	1294
$25 Potato	W. T. Woerner	1822
Stults' Special Mixture	Station	1670
Grain Manure	"	1671
The J. E. Tygert Co., Philadelphia, Pa.		
Bone Phosphate	H. O. Newcomb	1059
Cabbage Manure	S. Wood	1118
Gold Edge Potato Guano	H. I. Budd	1627
Vineland Grain Co., Vineland, N. J.		
Potato Manure	H. O. Newcomb	1168
Warren Fertilizer Works, Belvidere, N. J.		
Wheat and Corn	D. N. Warbasse	1438
Geo. M. Wells, Moorestown, N. J.		
Prosperity Potato Manure	H. I. Budd	1080
Fish Guano	"	1081
High-Grade Potato Manure	"	1082
West Jersey Marl and Trans. Co., Woodbury, N. J.		
Our Mixture for All Crops	W. Pettit	1274
Special Potato Manure	J. C. Griscom	1137
Farmers' Friend	H. O. Newcomb	1024
High-Grade Truck Manure	"	1025
W. E. Whann, William Penn, Pa.		
Fish and Potash	H. I. Budd	1296
Chester Valley Special Potato and Truck	"	1298
No. 2 Ammoniated Superphosphate	H. O. Newcomb	1027

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
......	0.24	2.15	2.39	1.64	9.06	2.57	0.62	12.25	10.50	11.63	9.50	3.97	2.00	$22 93	$26 00
0.23	......	1.77	2.00	1.64	3.68	4.96	3.11	11.75	10.50	8.64	9.50	3.15	2.00	18 86	29 00
......	......	1.27	1.27	0.82	9.96	3.21	0.77	13.94	11.00	13.17	10.00	3.34	1.00	20 38	25 50
1.64	......	1.81	3.45	3.28	4.96	5.59	0.95	11.50	....	10.55	8.00	10.05	10.00	29 85	35 00
0.53	......	1.54	2.07	1.64	2.96	4.29	0.17	7.42	....	7.25	7.00	6.18	3.00	18 98	26 00
......	......	1.57	1.57	1.64	5.08	2.17	3.11	10.36	....	7.25	10.00	9.64	10.00	21 70	24 50
1.14	......	1.33	2.47	2.46	4.12	2.44	2.09	8.65	....	6.56	8.00	10.24	10.00	23 55	32 00
......	......	1.15	1.15	0.82	3.76	4.63	2.15	10.54	....	8.39	8.00	2.32	2.00	14 90	20 00
1.27	......	1.92	3.19	3.28	4.50	3.40	0.97	8.87	....	7.90	7.00	9.37	9.00	25 96	30 00
1.61	......	1.59	3.20	2.87	4.28	2.21	2.55	9.04	....	6.49	9.00	10.15	10.00	25 74	30 00
0.60	......	1.69	2.29	2.46	6.44	2.77	2.03	11.24	....	9.21	11.00	3.73	3.00	20 28	27 00
0.28	......	1.46	1.74	1.64	3.48	4.50	1.23	9.21	....	7.98	8.00	7.27	7.00	20 10	25 00
0.28	......	1.83	2.11	2.05	2.18	8.24	4.18	14.	....	10.42	11.00	10.26	10.00	27 45	32 00
......	......	2.07	2.07	1.64	2.86	4.03	2.71	9.60	....	6.89	8.00	3.12	3.00	17 24	22 00
0.28	......	1.26	1.54	1.85	7.82	1.60	2.46	11.88	11.00	9.42	9.00	2.46	2.50	17 30	25 00
1.02	......	1.35	2.37	2.46	5.80	1.44	1.81	9.05	8.50	7.24	7.00	4.14	5.00	18 66	35 00
......	......	1.47	1.47	1.64	4.62	2.11	2.64	9.37	8.00	6.73	7.00	5.60	5.00	17 29	28 00
......	0.86	1.17	2.03	1.64	10.02	0.89	0.01	10.92	....	10.91	7.00	*9.04	10.00	26 53	30 00
0.63	......	0.41	1.04	1.00	3.36	2.65	1.35	7.36	....	6.01	6.00	7.54	5.00	16 03	25 00
0.64	......	1.41	2.05	1.85	1.56	5.42	4.85	11.83	....	6.98	7.00	11.34	10.00	24 86	28 00
......	......	2.09	2.09	2.05	1.48	4.41	6.36	12.25	....	5.89	8.00	4.73	2.00	19 14	22 50
0.78	0.34	1.76	2.88	2.87	1.14	4.70	7.21	13.05	....	5.84	7.00	9.00	9.00	25 26	30 00
......	......	2.01	2.01	2.05	4.60	3.20	2.03	9.83	....	7.80	6.00	4.18	4.00	18 59	22 00
......	......	2.09	2.09	2.05	3.72	3.47	1.78	8.97	....	7.19	5.00	10.83	10.00	23 79	28 00
......	0.87	1.67	2.54	2.46	6.14	1.74	1.30	9.18	....	7.88	7.00	5.13	5.00	20 97	28 00
0.72	......	2.39	3.11	3.28	4.06	4.91	1.80	10.77	....	8.97	6.50	9.38	8.50	27 30	32 00
0.53	......	0.84	1.37	1.48	1.66	5.36	1.58	8.60	....	7.02	8.00	5.69	5.00	16 65	28 00
0.77	......	1.53	2.30	2.46	3.78	2.85	1.09	7.72	10.00	6.63	7.00	7.49	7.00	20 49	32 00
0.29	......	1.24	1.53	1.23	2.48	3.71	1.39	7.58	9.00	6.19	7.00	4.89	3.00	15 68	22 00

*Potash largely, if not entirely, in form of sulfate. See page 38.

Home Mixtures and Special Compounds

Furnishing Nitrogen, Phosphoric Acid and Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
HOME MIXTURES.		
John S. Amerman, Neshanic, (No. 1)	H. S. Van Nuys	1358
" " (No. 2)	"	1352
H. H. Bell, Mount Ephraim	H. H. Bell	1090
Jos. Butterhof, Mullica Township	C. Kraus	1581
J. L. Schwickerath, Pomona	"	1554
H. Shirmer, Mullica Township	"	1580
David P. Voorhees, Hopewell	J. M. Dalrymple	1583
J. B. Warwick, Hartford	J. B. Warwick	1505
SPECIAL COMPOUNDS.		
Wm. C. Newport & Co., Willow Grove, Pa.		
Gloucester County Grange Fertilizer	J. T. Carter	0143
Moro Phillips Chemical Co., Philadelphia, Pa.		
Gloucester County Grange Sweet Potato	J. T. Carter	1008
M. L. Shoemaker & Co., Philadelphia, Pa.		
Pomona Grange Mixture No. 1	I. Miller	1668
" " " " 2	"	1669
The Taylor Provision Co., Trenton, N. J.		
Hagaman's Mixture	J. Hagaman	0182
Pomona Grange Grain Mixture	I. Miller	1226
" " Potato Mixture	"	1227
I. P. Thomas & Son Co., Philadelphia. Pa.		
Kerr's Mixture	J. R. Kerr	0180
Heath's Special Mixture	R. T. Heath	1199
Coopertown Farmers' Club, Improved Superphosphate	H. I. Budd	0188
" " " H. G. Potato Manure	"	0140
" " " Grain Special	"	0141
" " " Tip Top	"	0142
" " " Alkaline Bone	"	0189
Trenton Bone Fertilizer Co., Trenton, N. J.		
Voorhees Formula	S. T. Lewis	1140
Williams & Clark Fertilizer Co., New York City.		
Read's Potato Manure	W. O. Ward	1847
Bellemead Corn Fertilizer	P. A. Garretson	1663
" Potato Fertilizer	"	1664

Home Mixtures and Special Compounds

Furnishing Nitrogen, Phosphoric Acid and Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
0.74	......	2.07	2.81	......	2.88	8.84	1.18	6.85	....	5.72	....	4.65	....	$18 81	$25 00
0.50	......	1.89	1.89	......	8.86	4.84	2.20	10.40	....	8.20	....	2.13	....	16 74	20 00
0.73	0.48	0.93	2.14	......	2.10	8.48	0.99	6.52	....	5.53	....	5.01	....	16 79	....
0.95	......	1.09	2.04	......	5.78	1.83	2.60	10.21	....	7.61	....	8.04	....	21 53	20 80
1.86	......	1.73	3.59	......	2.54	7.27	7.80	17.61	....	9.81	....	4.49	....	27 50	....
......	0.60	1.96	2.56	......	3.14	3.83	2.26	9.23	....	6.97	....	5.98	....	21 20	23 45
......	......	1.64	1.64	......	2.86	9.81	0.78	12.95	....	12.17	....	15.12	....	30 58	32 00
0.70	1.10	1.38	3.18	......	0.20	13.06	4.08	17.34	....	13.26	....	9.49	....	33 57	....
0.62	1.12	1.83	3.57	3.49	4.86	2.65	2.46	9.97	10.50	7.51	6.00	9.61	8.75	27 96	26 85
......	0.22	1.83	2.05	2.05	2.52	6.22	3.78	12.52	11.00	8.74	6.00	11.04	10.00	26 22	23 90
1.01	......	1.12	2.13	2.05	2.14	5.71	4.40	12.25	....	7.85	8.00	6.99	6.00	21 96	21 50
......	......	1.34	1.34	0.82	5.68	4.08	3.67	13.43	....	9.76	9.00	5.18	3.00	19 92	16 50
......	......	0.84	0.84	0.82	2.68	3.78	3.36	9.82	....	6.46	9.00	5.55	5.00	†14 47	25 00
1.16	0.20	1.06	2.42	2.46	8.06	2.38	2.50	12.94	....	10.44	9.00	2.84	2.00	21 15	19 40
1.29	0.21	1.19	2.69	2.46	6.38	2.33	2.1[illegible]	10.86	....	8.71	7.50	7.11	8.00	23 72	24 60
......	......	1.49	1.49	......	4.96	6.18	4.67	15.83	....	11.16	....	1.42	....	†17 74	25 00
......	0.81	0.66	1.47	0.63	4.02	5.91	2.88	12.84	....	9.96	10.00	*2.85	2.00	18 74	20 00
......	......	1.52	1.52	0.82	13.12	0.75	0.41	14.28	....	13.87	10.00	*2.87	1.00	21 76	25 00
......	2.99	1.15	4.14	2.46	8.58	0.93	0.22	9.73	....	9.51	8.00	*10.77	10.00	33 92	33 00
......	1.15	0.81	1.96	0.82	10.70	1.77	1.05	13.52	....	12.47	7.00	*2.49	1.00	21 77	23 00
......	1.68	2.04	3.72	2.46	9.70	1.01	0.68	11.39	....	10.71	8.00	*5.78	4.00	28 83	32 00
......	......	......	......	......	13.96	1.14	0.27	15.39	....	15.12	10.00	*2.81	2.00	18 04	20 00
0.96	......	3.07	4.03	......	4.20	4.97	1.97	11.14	....	9.17	....	*10.15	....	32 13	37 00
0.34	0.57	1.78	2.64	......	4.74	2.55	1.79	9.08	....	7.29	....	11.56	....	26 21	22 25
0.39	......	1.04	1.43	1.23	2.62	4.80	3.46	10.88	7.00	7.42	6.00	5.38	5.00	17 79	18 50
0.74	0.54	1.68	2.96	3.23	3.16	5.35	3.02	11.53	9.00	8.51	8.00	6.42	7.00	24 41	26 50

* Potash largely, if not entirely, in form of sulfate. See page 38. † 1900 valuation.

Ground Bone

Furnishing Nitrogen and Phosphoric Acid.

Station Number.	BRAND.	MANUFACTURER.
1193	Ground Bone	American Agricultural Chemical Co., N. Y. City
0127	*Pure Bone Meal (Williams & Clark)	" " " " " "
1509	Bone Meal	Armour Fertilizer Works, Chicago, Ill
1510	Pure Ground Bone	Allentown Manufacturing Co., Allentown, Pa
1377	Raw Bone	The Berg Co., Philadelphia, Pa
1096	Market Bone	Bowker Fertilizer Co., Boston, Mass
1595	Fresh Ground Bone	" " " " "
1066	Steamed Bone, No. 1	J. S. Collins & Son, Moorestown, N. J
1067	Steamed Bone, No. 2	" " " " "
1402	Pure Bone Dust	Peter Cooper's Glue Factory, New York City
1415	Pure Ground Bone	Ira Hill, Copper Hill, N. J
1257	Pure Ground Bone	Hires & Co., Quinton, N. J
1527	Pure Ground Bone	The Mapes Formula & Peruvian Guano Co., N.Y. City
1404	Pure Raw Bone Meal	Wm. C. Newport & Co., Willow Grove, Pa
1317	Ground Bone	Ruckmann Bros., New Brunswick, N. J
1444	Swift-Sure Bone Meal	M. L. Shoemaker & Co., Philadelphia, Pa
1370	Pure Bone	Somerset Chemical Co., Bound Brook, N. J
1112	Pure Bone Meal	Swift & Co., Chicago, Ill
0125	*Fine Ground Bone	I. P. Thomas & Son Co., Philadelphia, Pa
0135	*Slaughter-House Bone	" " " " " "
1490	Pure Ground Animal Bone	" " " " " "
1020	Button Bone Dust	Emil Wahl, Philadelphia, Pa
1435	Ground Bone	Warren Fertilizer Works, Belvidere, N. J
1023	Pure Bone Meal	West Jersey Marl and Trans. Co., Woodbury, N. J
1580	Bone Sawings	Winterbottom, Carter & Co., Egg Harbor City, N. J

* Samples of 1900, received too late for last bulletin. Valued by 1900 Schedule.

Ground Bone

Furnishing Nitrogen and Phosphoric Acid.

SAMPLER.	Station Number.	Mechanical Analysis. Finer than 1-50th in.	Mechanical Analysis. Coarser than 1-50th in.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phosphoric Acid.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
J. W. Pincus	1198	60	40	2.20	28.42	$26 79	$21 50
W. W. Bodine	0127	55	45	2.90	28.58	24 57	23 25
J. J. Mitchell	1199	61	39	3.21	25.74	27 85	35 00
"	1510	53	47	3.90	21.88	26 46	32 00
F. E. Woodruff	1377	37	63	3.80	22.92	25 69	31 50
S. Wood	1096	44	56	1.86	26.72	23 51	35 00
J. B. Ward	1595	31	69	2.45	25.16	23 15	32 00
H. I. Budd	1066	56	44	1.77	27.96	24 95	25 00
"	1067	75	25	2.79	24.92	27 06	23 00
H. O. Newcomb	1402	55	45	1.45	28.70	24 50	22 00
A. Dilts	1415	51	49	3.84	20.96	25 49	27 00
W. Pettit	1257	70	30	2.28	27.66	27 22	26 00
J. J. Mitchell	1527	36	64	3.04	17.50	19 95	35 00
H. O. Newcomb	1404	34	66	3.98	23.98	26 53	28 00
W. T. Woerner	1317	42	58	3.75	22.88	25 92	25 00
D. N. Warbasse	1444	46	54	5.38	23.18	30 92	33 00
J. M. Dalrymple	1370	50	50	3.84	20.00	24 75	27 00
S. Wood	1112	83	17	2.75	25.62	28 06	23 00
Wm. Dubon	0125	44	56	2.87	16.86	19 05	....
J. Q. Holcombe	0185	53	47	1.15	17.26	15 55	21 35
J. M. Dalrymple	1490	50	50	3.31	23.28	25 56	32 00
H. O. Newcomb	1020	67	33	3.14	23.86	26 73	29 00
D. N. Warbasse	1435	14	86	3.91	22.96	24 24	28 00
H. O. Newcomb	1023	50	50	3.97	21.42	26 12	30 00
C Kraus	1580	90	10	3.80	26.60	32 60	30 00

Miscellaneous Fertilizers

Furnishing Nitrogen, Phosphoric Acid or Potash.

MANUFACTURER AND BRAND.	SAMPLER.	Station Number.
American Agricultural Chemical Co., New York City.		
Bradley's Alkaline Bone with Potash	J. J. Mitchell	1519
Read's Alkaline Bone	A. Dilts	1422
Susquehanna Soluble Bone Phosphate	W. O. Ward	1346
Armour's Fertilizer Works, Chicago, Ill.		
Dissolved Bone	J. J. Mitchell	1509
Bowker Fertilizer Co., Boston, Mass.		
Superphosphate with Potash	W. O. Ward	1329
E. Frank Coe Co., New York City.		
High-Grade Dissolved Bone and Potash	H. I. Budd	1061
Lister's Agricultural Chemical Works, Newark, N. J.		
Celebrated Ground Bone Acidulated	F. E. Woodruff	1396
The Mapes Formula and Peruvian Guano Co., New York City.		
Ammoniated Dissolved Bone	J. B. Ward	1604
Mixner & Mickel, Bridgeton, N. J.		
Phosphate and Potash	H. O. Newcomb	1054
Wm. C. Newport & Co., Willow Grove, Pa.		
Soluble Bone and Potash Phosphate	J. M. Dalrymple	1247
Ruckmann Bros., New Brunswick, N. J.		
Flesh and Bone	W. T. Woerner	1318
M. L. Shoemaker & Co., Philadelphia, Pa.		
Swift Sure Dissolved Bone	C. Kraus	1549
Lester Shurts, Neshanic, N. J.		
Corn Special	H. S. Van Nuys	1351
Somerset Chemical Co., Bound Brook, N. J.		
Degelatinized Bone	H. O. Newcomb	1151
I. P. Thomas & Son Co., Philadelphia, Pa.		
Alkaline Bone	A. Dilts	1428
Improved Animal Bone	J. M. Dalrymple	1498
Trenton Bone Fertilizer Co., Trenton, N. J.		
Corn Special	D. N. Warbasse	1449
Wool Waste	S. Wood	1114
" "	"	1592
" "	"	1596
Snuff Sand	C. H. Herbert	1504

Miscellaneous Fertilizers

Furnishing Nitrogen, Phosphoric Acid or Potash.

Nitrogen.					Phosphoric Acid.							Potash.			
										Available.					
From Nitrates.	From Ammonia Salts.	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
......	......	......	......	.....	3.90	5.46	3.31	12.67	11.00	9.36	10.00	1.96	1.00	$12 35	$20 00
......	......	......	......	......	5.52	4.44	3.18	13.14	12.00	9.96	10.00	1.88	2.00	12 83	18 00
......	......	......	.....	.....	13.06	2.73	1.10	16.89	15.00	15.79	14.00	....	....	*7.9	25 00
......	......	2.65	2.65	1.64	8.18	7.82	0.98	16.98	....	16.00	11.00	....	....	24 87	32 00
......	......	......	......	......	4.28	5.93	2.87	13.08	12.00	10.21	10.00	1.17	1.00	12 36	18 00
......	......	......	......	......	5.30	3.88	4.11	13.29	12.50	9.18	10.50	2.32	2.00	12 79	24 00
......	0.38	2.97	3.35	2.67	....	6.21	9.17	15.38	12.00	6.21	....	....	....	20 63	27 00
......	......	1.57	1.57	1.23	1.84	8.11	2.02	11.97	12.00	9.95	10.00	2.40	1.50	17 82	32 00
......	... ..	......	......	......	6.86	3.98	2.08	12.92	....	10.84	10.00	1.95	2.00	13 33	16 00
......	......	......	......	.....	0.78	5.20	2.17	8.15	10.00	5.98	8.00	3.00	3.00	9 40	....
......	0.61	3.15	3.76	2.75	1.02	5.98	9.79	16.79	10.00	7.00	6.00	....	....	23 01	20 00
......	......	2.20	2.20	1.64	8.30	4.93	6.55	19.78	13.00	13.23	10.00	....	....	22 89	28 30
......	......	......	......	......	8.34	5.52	1.48	15.34	....	13.86	12.00	3.38	3.00	17 32	16 00
......	0.69	0.51	1.20	1.23	....	14.20	13.02	27.22	28.00	14.20	15.00	....	....	23 32	25 00
......	......	......	......	.....	3.18	7.70	0.93	11.81	12.00	10.88	10.00	2.67	2.00	13 52	19 00
......	......	1.32	1.32	1.64	4.14	8.25	9.51	21.90	20.00	12.39	12.00	....	....	20 41	26 00
0.28	......	3.44	3.72	4.10	7.94	3.38	1.93	13.25	....	11.32	9.00	....	....	23 88	32 00
......	......	2.34	2.34	......	....	....	....	0.55	....	....	....	1.21	....	....	2 50
......	......	2.31	2.31	......	....	....	....	0.52	....	....	....	3.12	....	....	2 50
......	......	2.47	2.47	......	....	....	....	0.44	....	....	....	2.29	....	....	2 50
......	......	1.03	1.03	......	....	....	....	0.36	....	....	....	1.09	....	....	....

*Cost per pound in cents of available phosphoric acid.

Sundry Materials.

0133. Canada Wood Ashes. Made by F. R. Lalor, Dunville, Ontario, Canada. Sent by C. M. Randolph, Bound Brook.

1084. Wood Ashes. Made by The Tyler-Hall Chemical Co., Readburn, N. Y. Sent by Stephen Roy, Glenwood.

1141. Canada Wood Ashes. Made by F. E. Hancock, Walkerton, Ontario, Canada. Sent by Wm. M. Brown, Cedarville.

1197. Canada Wood Ashes. Made by F. E. Hancock, Walkerton, Ontario, Canada. Sent by John Scullin, Hammonton.

1304. Canada Wood Ashes. Made by G. L. Munroe, Oswego, N. Y. Sent by P. G. Staats, Bound Brook.

1382. Wood Ashes. Made by Bowker Fertilizer Co., Boston, Mass. Sent by A. M. Griffen, Plainfield.

1407. Canada Wood Ashes. Sent by H. O. Newcomb, Cedarville.

1672. Wood Ashes. Made by Bowker Fertilizer Co., Boston, Mass. Sent by P. G. Staats, Bound Brook.

1673. Wood Ashes. Made by Bowker Fertilizer Co., Boston, Mass. Sent by P. G. Staats, Bound Brook.

	0133	1084	1141	1197	1304	1382	1407	1672	1673
	%	%	%	%	%	%	%	%	%
Phosphoric Acid	1.77	1.75	1.31	1.42	1.49	1.59	1.47	1.55	1.50
Potash	2.77	1.71	3.94	4.83	5.58	6.76	6.21	6.84	5.40
Lime	31.50	28.97	28.06	33.16	34.78	33.78	33.14	34.87	31.16
Valuation per ton	$4.19	$3.11	$4.99	$5.47	$6.77	$8.03	$7.39	$8.08	$6.60
Selling price per ton	9.00	8.00	10.75	12.00	10.50	....	11.00	10.50	10.50

0144, 0145, 0146, 0147. Marl. Sent by M. Crine, Morganville, N. J. It represents a total deposit of 500,000 tons, and the samples are taken from three local deposits, being respectively, upper part of No. 1, lower part of No. 1, No. 2 and No. 3. Selling price, 15 cents per ton.

0148. Marl. Sold by West Jersey Marl and Transportation Co., Woodbury, N. J. Sample taken from deposit near Sewell, N. J., and sent by J. M. Moore, Clayton.

	0144	0145	0146	0147	0148
Phosphoric Acid	1.54	1.06	0.94	0.95	1.44
Total Potash	1.68	1.01	1.48	1.28	1.81
Lime	1.70	4.11	0.87	0.46	1.58

0149. Garbage Refuse. Made by James Ross, Trenton, N. J. Sent by C. H. Cook, Trenton, N. J. Selling price, $2 per ton. It contains 2.07 per cent. phosphoric acid, 1.17 per cent. potash and 7.92 per cent. lime.

1004. Lime. Sent by M. F. Gano, Annandale, N. J. It contains 53.17 per cent. calcium oxid.

Appendix.

Station Number.	MANUFACTURER AND BRAND.	SAMPLER.
	B. F. Demarris & Son, Cedarville, N. J.	
1038	Fish Guano	H. O. Newcomb
	Wyckoff Hendrickson, Allentown, N. J.	
1360	Special Grain Manure	J. M. Dalrymple
	Frank Maul, Greenwich, N. J.	
1147	Grain Manure	H. O. Newcomb
	John E. Minch, Bridgeton, N. J.	
1148	Complete Phosphate	H. O. Newcomb
	Vineland Grain Co., Vineland, N. J.	
1164	Bone Phosphate	H. O. Newcomb
	Wm. C. Newport & Co., Willow Grove, Pa.	
1139	Evans Brand, Potato Manure	S. T. Lewis.

Station Number.	Nitrogen.					Phosphoric Acid.							Potash.		Value of 2,000 lbs. at Station's Prices.
	From Nitrates.	From Ammonia Salts.	From Organic Matter.	**Total Found.**	**Total Guaranteed.**	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	**Total Found.**	**Total Guaranteed.**	**Available.** Found.	**Available.** Guaranteed.	Found.	Guaranteed.	
1038	......	1.22	2.09	3.31	2.46	8.20	0.84	0.80	9.84	....	9.04	7.50	7.27	2.00	$26 26
1360	1.52	......	1.61	3.13	1.23	5.94	3.22	2.24	11.40	....	9.16	8.00	5.43	3.00	24 09
1147	......	1.05	0.79	1.84	0.82	10.38	1.66	0.89	12.93	....	12.04	7.00	*2.92	1.00	21 32
1148	0.36	......	1.24	1.60	2.05	11.76	0.50	0.17	12.43	....	12.26	9.00	*6.76	2.50	23 87
1164	......	......	1.13	1.13	1.03	10.16	1.86	0.66	12.68	....	12.02	8.50	*6.67	1.50	21 73
1139	0.76	......	1.29	2.05	3.28	5.78	1.66	1.71	9.15	8.00	7.44	6.00	9.34	10.00	22 32

*** Potash largely, if not entirely, in form of sulfate. See page 83.**

FODDERS AND FEEDS.

I.

CONCENTRATED FEEDING STUFFS.

Introduction.

The Legislature of the State of New Jersey, on March 15th, 1900, passed a law regulating the sale of feeding stuffs in the State in much the same manner as the sale of fertilizing materials has been regulated for the quarter-century past. A copy of the full text of this law will be sent to anyone interested, upon application. Briefly stated, the law requires—

1. That every lot or parcel of certain concentrated feeding stuffs (for domestic animals), sold in this State shall have affixed thereto, in a conspicuous place on the outside, a printed statement of—

The number of net pounds contained.
The name or trade-mark of the material.
The name of the manufacturer or shipper.
The percentage of protein contained, and the percentage of fat contained.

If the feeding stuff is sold in bulk, or in packages belonging to the purchaser, this statement shall be furnished by the agent or dealer to the purchaser.

2. A certified copy of this statement shall be filed with the Director of the Experiment Station in the month of November of each year, accompanied, when requested, by a sample of the goods.

3. The feeding stuffs which are required to conform with these provisions of the law include—

Brewers' grains, dried,
Cerealine feeds,
Cocoanut meals,
Corn and oat chop,
Cottonseed meals,
Gluten meals,
Hominy feeds,
Linseed meals,
Maize feeds,
Malt sprouts,
Meat scrap, ground,
Mixed feeds,
Oat feeds,
Pea meals,
Rice meals,
Sugar feeds,
Starch feeds,
And all similar materials.

4. The following feeding stuffs are exempted from the requirements of the law:

All kinds of hay and straw.

The whole seeds of wheat, barley, rye, oats, Indian corn, buckwheat and broom corn, and the unmixed meals made from the entire grains of any of these.

The meals made from pure grains ground together.

The brans and middlings of wheat, rye and buckwheat, when separate and unmixed with any other substances.

5. Should any of these materials, otherwise exempt, be mixed or adulterated with any substance for the purpose of sale, the package which contains it, or in which it is offered for sale, must have plainly marked or indicated thereon the true composition of the mixture, or the character of the adulteration.

6. The Experiment Station is authorized to have collected samples of every kind of material used in the feeding of domestic animals, to analyse them and to publish the results. Penalties, varying from $25 to $200, are provided for violations of the law.

The Reasons for the Law.

The reasons for a State control of feeding stuffs are much the same as for the control of fertilizers, to which it is analogous. As, formerly, the agriculturist depended upon his farm stock alone for his fertilizing material, but at this later date is taught by principle and practice to supplement the same by the purchase of commercial fertilizers, so in like manner the dairyman formerly depended upon his farm alone for his cattle food, but later has come to the use of supplementary materials. There are sound scientific principles for this development of practice, and as they have become more generally known and practiced, the use of concentrated feeding stuffs has increased, as was the case with fertilizers. And, as with fertilizers, so with feeds is it the case that a multiplicity of materials are offered to catch the dairyman's favor, with new ones appearing almost every day.

The greater part of these feeds, which are offered to draw the farmer away from the brans and middlings and meals of his local miller, are secondary, or by-products from the manufacture of other products primarily for the use of man. Thus linseed meal is the residue from the manufacture of linseed oil, the use of which in the arts is well

known. In like manner, we have the cottonseed meal from the cotton industry, gluten meal from the starch, and also from the glucose industry, cerealine feed, hominy feed, oat feed, etc., from the manufacture of what, as a class, has come to be called "breakfast foods," and other by-products from other processes of manufacture.

The first intention and main purpose of the manufacturer being to produce the linseed oil, or the starch, or the glucose, etc., it was but natural that the secondary products, which were offered as food for cattle, should not in many cases receive the care that would insure a uniform product of the highest degree of purity. For example, gluten meal at times would be the pure glutinous portion of the corn kernel, and at other times would have more or less of the bran and other portions of the corn mixed with it. Cottonseed meals in most instances have been the pure meat of the cottonseed, ground after cooking, and pressing out the oil, but in not a few instances have the hulls been included, thus reducing the value of the product by one-half, without considering the disadvantage of the presence of the indigestible hulls.

Besides this lack of care in keeping the side product in the highest degree of purity, or at least uniformity, the fact of a large number of factories putting out the same, or similar products, has led to further confusion, for as their processes may differ or undergo alteration, so will their side products. For example, there is a difference in the linseed meal (sometimes called "cake meal" and "oil meal"), made in the extraction or new process, and that made in the old process by pressure, whereas the main product of the factory—the linseed oil—is essentially the same by the two processes. So with the various by-products put on the market under the brand name of gluten meal. The same name has been used to designate materials varying widely in their composition, including both the true gluten meals and also the less nitrogenous forms, which are variously termed gluten feed, sugar feed, starch feed, etc. Oat feeds, also, include under the one designation feeds of considerable variability.

In addition to these considerations, there is the possibility of actual intentional adulteration to be guarded against, and there is no limit to which it may be carried. Our neighboring States have taken notice of this condition of affairs, and have passed laws similar to this in New Jersey, whereby it is required that this class of goods be guaranteed, and it be seen to that the guarantees are fulfilled. Without such a law as this in New Jersey also, it would be the most natural thing to expect that manufacturers having on hand two

batches of feed, the one superior to the other, would send the better to the locality where such goods are scrutinized and the poorer to the State where they are not.

For our own protection as a State, therefore, and for the protection of our cattle and horse feeders, it is necessary to have such a law in operation as has been outlined in the opening of this section. And not only for the protection of our feeders will this law operate, but also for the protection of our local millers, who are putting on the market the very highest grades of home-grown products, honestly made. There is no question but that they will be benefited by a clear exposition of the character of many of these feeds, which come, as novelties, into competition with the old-established line.

No manufacturer, however, whether local or in another section of our country, who is conducting his business in an open and above-board manner and selling his goods on their merits, can fail to be benefited by a law which places all goods upon a fair basis, for, by the operation of this law, all goods are brought to the attention of the consumer and their merits clearly portrayed. Analysis shows which are the better adapted for the purpose in hand ; the consumer thereby is enabled to purchase with understanding, and apply his purchased material to the use to which they are best adapted, whether for milk, butter, flesh, work or maintenance, or as supplements to rations intended for these purposes. Misapplication of valuable feeds is thereby reduced to a minimum, and from their use results the maximum of profit. Confidence in the material, and ability to purchase further is thus established, which it is not likely would be the case had it been used without knowledge of its character. The rational consumption of feeds of all classes is consequently increased with profit to both producer and consumer.

To the feeder will this work prove of exceptional value, since it will direct his notice to many new and valuable sources of supply. To the local miller will it prove no disadvantage, for the mills are few which *can* supply the demand for bran and kindred old line products, without purchasing outside, and hence should the demand for these decrease through the use of the newer forms of feeds, all that would be necessary would be to meet the conditions by handling the new feeds ; and to the manufacturers of these new feeds will it prove anything but a disadvantage, since that time can be devoted to making the very best product of which their plant is capable, which would otherwise be devoted to watching and meeting their competitors.

Sampling and Analyses.

Early in the fall of 1900 the Experiment Station made ready to carry out the provisions of the law. Copies of the latter, with an explanatory circular, were sent to all the millers and dealers in feeds so far as their names and addresses could be secured. In many cases these elicited requests for further information as to the liability of particular individuals, or in the case of particular kinds of feeding stuffs, all of which information the Station cheerfully afforded so far as lay in its power. In accordance with that section of the law requiring the same (see paragraph 2 of the abstract of the law at the beginning of this section), manufacturers or dealers quite generally furnished a certified copy of the statements which would accompany their goods in their sale, and several sent in addition sealed samples of the goods themselves, although this is not required unless the Experiment Station requests it.

Mr. D. N. Warbasse, of Newton, was appointed Deputy Collector of samples, and armed with the necessary bottles, shipping cases and other paraphernalia, proceeded to scour the State until interrupted by serious illness, when the work was continued by a member of the Station staff working in connection with his other duties. The entire State, therefore, has not received an equally thorough inspection. Nevertheless, 20 of the 21 counties were visited and 529 samples collected. Of these, 60—all duplicates, and further duplication being unnecessary—have been discarded and 469 have been analyzed, yielding the results which appear in tabulated form upon subsequent pages. The character of these samples, the number of each kind received, and the number analysed, are shown in the following table:

Feeds Received and Analysed.

	Rec'd.	Ana-l'd.
American Calf Meal	2	2
" Poultry Food	3	2
Animal Meal, Meat, etc.	7	5
Banner Stock Food	2	1
Barley Meal	1	1
Baum's Horse and Stock Food	1	1
Blatchford's Calf Meal	4	3
Brewers' Grains, dried	17	15
Cerealine Feeds	10	8
Chester Stock Food	10	10
Clover Meal	1	1
Cob Meal (Corn Ear Meal)	11	11
Corn and Oats	36	32
Cottonseed Meal	37	37
Dairy Feeds, miscellaneous	6	6
De Fi Corn and Oat Feed	1	1
Durham Corn and Oat Feed	1	1
Flaxseed Meal	7	7
Friends' Concentrated Dairy Feed	4	4
Germ Oil Meal	4	4
Gluten Feed, Buffalo	25	16
" Davenport	3	3
" Marshalltown	1	1
" Nation'l Starch	7	7
" Rockford Diamond	4	4
" Waukegan	1	1
Gluten Feed, miscellaneous	2	2
Gluten Meal, Chicago	7	6
H. O. Dairy Feed	6	5
" Horse Feed	10	8
" Poultry Feed	10	7
" Scratching Feed	2	2
Hominy Meal or Feed	24	20
Horse Feeds	52	49
Linseed Meals	74	68
Maizeline	1	1
Malt Sprouts	25	23
Poultry Feeds, miscellaneous,	5	5
Quaker Dairy Feed	12	8
Rice Feed	2	2
Royal Feed	2	2
Rye Bran	1	1
" Feed	1	1
" Middlings	1	1
Schumacher Stock Feed	3	2
Sucrene Dairy Feed	1	1
Star Chop	1	1
Sugar Beet Feed	1	1
Sugar Feed (Corn Bran)	15	12
Victor Corn and Oat Feed	15	12
Vim Oat Feed	6	6
Wheat Bran and Ship Stuff	18	18
Wheat Feeds	9	7
Unclassified	17	14

The analyses of these samples were made according to law by the methods of the Association of Official Agricultural Chemists, and included the determination of protein and fat (ether extract), and, in some cases, of fiber or other constituents, as the circumstances in the case seemed to warrant.

Classification of Feeds.

A study of the feeds which have been analysed will make it apparent that they should be separated into two classes, widely different in analysis in their extremes, and yet so approaching each other in character as to present no sharp dividing line where we shall say one class ends and the other class begins. The distinguishing feature of these two classes consists in the content of protein, which is commonly called the flesh-forming constituent of food, and which is similar to the white of egg and the gluten of wheat. Feeds containing considerable of this nutrient may, therefore, be called *protein feeds*, of which cottonseed meal, linseed meal and the gluten meals may be mentioned as examples. These feeds are purchased for the express purpose of improving the ration by the addition of protein, when the feeds and fodder on hand are low in that constituent.

The latter class of feeds, being low in their content of protein, are consequently high in the other constituents which are called the carbohydrates, of which sugar and starch are the purest examples. Feeds consisting, in greater part, of the carbohydrates may, therefore, be called *carbohydrate feeds*, and of these corn meal is probably the best example. Materials of this nature are not suitable additions to the feeding materials usually raised on the farm, since they themselves require the addition of protein feeds the same as the farm products do. Farmers usually have an abundance of carbohydrate feed on hand, and hence these feeds appeal to the city feeders of horses or stall-fed cattle.

The analyses of the feeds which have been examined are, therefore, tabulated so as to separate them into the (1) Protein Feeds, and (2) Carbohydrate Feeds. To this there is added (3) Feeds Made from Whole Grains, Ground Together, and (4) Poultry Food and Stock and Condimental Foods. The classification in detail, showing the average percentages of protein, fat and, in some cases, fiber, and the average selling prices per ton reported is to be found on the next page, after which follow the analyses of the individual samples in detail.

The Average Analyses and Price of Feeds Examined in 1901.

I. Protein Feeds.

	Protein.	Fat.	Fiber.	Selling Price.
Cottonseed Meal	45.71	9.48	......	$28 70
Chicago Gluten Meal	37.60	3.91	......	26 08
Linseed Meal	33.30	7.49	......	34 08
Flaxseed Meal	24.58	37.40	......	....
Marshalltown Gluten Feed	29.20	3.44	......	22 00
Rockford Diamond Gluten Feed	27.32	3.34	......	21 10
Buffalo Gluten Feed	26.51	3.60	......	21 87
Waukegan Gluten Feed	26.36	4.34	......	21 50
National Starch Co.'s Gluten Feed	25.88	3.96	......	21 86
Malt Sprouts	25.59	2.59	......	17 50
Dried Brewers' Grains	25.57	7.74	......	19 06
Davenport Gluten Feed	24.39	3.75	......	20 70
Sucrene Dairy Feed	21.75	6.90	8 96	21 00
H. O. Dairy Feed	18.42	3.85	12.75	22 70
Hoosier Mill Feed	18.39	4.70	7.07	20 00
Rankin's Wheat Feed	17.29	4.37	5.86	19 00
Buckeye Feed	17.13	4.49	5.94	20 33
Ship Stuff	17.12	4.28	6.77	18 50
National Milling Co.'s Wheat Feed	17.02	4.62	8.34	19 00
Wheat Bran	16.63	4.78	8.62	21 13
Harter's Mixed Feed	16.44	4.39	7.60	19 00
Germ Oil Meal	16.29	9.65	......	22 75

II. Carbohydrate Feeds.

Glucose Sugar Refining Co.'s Corn Bran or Sugar Feed	13.36	3.44	12.00	$17 10
Quaker Dairy Feed	13.19	3.22	17.64	18 86
H. O. Horse Feed	12.61	3 89	9.63	21 88
C. H. Kirby's Dairy Feed	12.48	3.24	5.29	18 50
J. C. Smith & Wallace's Dairy Feed	12.31	5.00	6.06	19 00
Schuhmacher Stock Feed	11.38	4.61	11.47	20 00
Hominy Meal or Feed	10.83	8.59	......	19 05
Taylor Bro.'s Dairy Feed, No. 2	10.80	3 54	9.67	17 50
J. A. Lydecker's Dairy Feed	10.51	7.42	7.33	20 00
Mixed Horse Feeds	10.38	4.66	5.22	20 68
Sugar Feeds (other than above)	9.69	5.18	12.49	17 64
Cerealine Feeds	9.55	6.88	......	19 75
Corn Meal	9.07	4.30	......	22 00
Victor Corn and Oat Feed	8.73	4.09	10.80	18 55
De Fi Corn and Oat Feed	8.70	3.13	14.89	19 00
Friend's Concentrated Dairy Feed	7.98	3.39	22.18	16 13

	Protein.	Fat.	Fiber.	Selling Price.
Taylor Bros.' Oat Feed	7.79	3.24	21.53	$15 00
Warren Beatty's Dairy Feed	7.47	3.84	6.88	17 00
Durham Corn and Oat Feed	7.47	2.80	13.06	20 00
Chester Stock Food	7.43	3.36	11.11	18 75
Royal Oat Feed	7.32	3.50	22.74	16 00
Vim Oat Feed	5.64	2.19	28.05	16 10
Sitley & Son's Oat Feed	3.32	1.20	31.42	14 50
Oat Chop	2.68	1.08	31.96	15 66
Sharpless & Bros.' Oat Feed	2.46	1.03.	32.41	....

III. Feeds Made from Whole Grains.

	Protein.	Fat.	Fiber.	Selling Price.
Horse Feeds	9.76	3.63	5.09	$21 56
Corn and Oats (Provender)	9.69	4.47	3.99	20 90
Corn Ear Meal ("Cob Meal")	7.73	3.52	5.90	15 41

IV. Poultry, Stock and Condimental Foods.

	Protein.	Fat.	Fiber.	Selling Price.
H. O. Poultry Feed	17.39	5.53	4.67	$30 86
H. O. Scratching Feed	12.32	4.43	......	32 00
American Poultry Food	12.99	6.57	4.74	28 00
Anderson's Old Fowl Mixture	17.86	5.72	4.26	26 00
Hopkins & Lippincott's Poultry Feed	18.23	9.11	7.46	30 00
Paul T. Norton Poultry Feed	15.46	4.44	4.60	23 00
Fidelity Food for Young Chicks	19.85	6.67	......	......
Blatchford's Calf Meal	24.90	5.29	4.66	68 33
American Calf Meal	17.44	8.01	2.32	41 00
Banner Stock Food	22.84	8.40	......	160 00
Baum's Horse and Stoek Food	24.84	*9.20	18.32	200 00
Bowker's Animal Meal	42.05	8.31	......	46 66
Bowker's Ground Beef Scrap	53.59	14.92	......	50 00
Shoemaker's Ground Meat for Poultry	60.91	13.01	......	52 00

* Ether extract, including much sulphur.

I. PROTEIN FEEDS.

1. Cottonseed Meal.

Station Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	American Cotton Oil Co., N. Y. City.		%	%	%	%	
1172	J. H. Blauvelt & Sons	Ridgewood	41.56	48	9.10	9	$30 0
1194	J. C. Smith & Wallace Co	Newark	46.85	48	8.87	9	27 00
1195	Wilkinson, Gaddis & Co	Newark	46.08	48	8.69	9	28 00
1237	Jaqui & Co.	Morristown	47.81	43	10.10	9	30 00
1238	Jos. Benedict	Elizabeth	46.69	48	10.04	9	29 00
1239	Van Zandt & Voorhees	Plainfield	46.60	48	9.65	9	33 00
1317	Allen & Stults	Trenton	45.00	48	8.80	9	28 00
1401	J. K. Waddington	Salem	44.88	48	9.64	9	29 00
1542	J. L. Hope	Madison	51.49	43	9.16	9	25 60
1286	C. Pountney	Elizabeth	46.08	48	9.74	9	27 00
1498	T. A. Ward	Freehold	45.90	48	9.20	9	30 00
	Cotton Oil and Fiber Co., Norfolk, Va.						
1198	Drake & Co	Newark	43.21	48	8.68	9	29 00
1220	Carscallen & Cassidy	Jersey City	48.21	48	8.80	9	30 00
1341	Sharpless & Bro.	Camden	47.86	48	8.64	9	26 00
1379	S. L. Pancoast	Mullica Hill	48.55	48	8.72	9	30 00
1407	C. G. Lippincott	Salem	47.29	43	9.02	9	28 00
1425	M. E. Lush	Vineland	47.40	48	9.34	9	30 00
1426	J. J. Hunt	Vineland	47.69	48	9.31	9	30 00
1367	Taylor Bros.	Camden	47.12	43	9.17	9	26 00
1421	Fithian & Pennell	Bridgeton	46.08	48	10.11	9	30 00
1422	Mixner & Mickle	Bridgeton	44.66	43	11.52	9	30 00
1423	W. O. Garrison	Bridgeton	47.43	48	10.21	9	30 00
1430	Vineland Grain Co	Vineland	46.83	43	9.04	9	28 00
1438	E. L. Ross	Cape May C. H.	45.86	48	9.99	9	32 00
1490	Colkitt & Thomson	Mt. Holly	47.59	48	9.21	9	29 00
1502	J. P. Wyckoff	Manasquan	41.51	48	10.84	9	32 00
	Cole, Cleaveland & Curley, N. Y. City.						
1181	C. A. Wilson	Deckertown	45.51	43	10.20	9	27 00
1146	Simmons & Martin	Deckertown	46.14	43	10.89	9	27 00
	Chapin & Co., St. Louis, Mo.						
1652	W. H. Ingersoll	Hamburg	43.76	48	7.72	9	27 00
	J. E. Soper & Co., Boston, Mass.						
1239	A. Cyphers.	Newark	48.09	43	9.11	9	28 00
	F. S. Walton & Co., Philadelphia, Pa.						
1121	Samuel Thomas	Phillipsburg	45.73	48	9.95	9	29 00
	F. W. Brode & Co., Memphis, Tenn.						
1380	Sitley & Son	Camden	42.71	48	8.20	9	....
1467	Hopkins & Lippincott	Moorestown	38.03	43	12.88	9	27 00
1468	J. S. Collins & Son	Moorestown	39.60	43	9.46	9	28 00
	Simpson, Hendee & Co., N. Y. City.						
1326	L. B. Risdon	Trenton	44.20	48	8.00	9	28 00
	Hunter Bros., St. Louis, Mo.						
1356	C. H. Kirby	Medford	46.14	43	10.18	9	27 50
	Sledge & Wells Co., Memphis, Tenn.						
1544	J. E. Stevenson	Columbus	41.19	......	9.79	......	....
		Average	45.71	......	9.48	......	28 70

I. PROTEIN FEEDS.

2. Linseed Meal, Oil Meal, or Cake Meal.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Selling Price per Ton.
	American Linseed Co., Chicago, Ill.		%	%	%	%	
1148	C. A. Wilson	Deckertown	32.76	32	6.75	5	$33 00
1179	J. H. Blauvelt & Sons	Ridgewood	32.18	32	7.79	5	32 00
1197	Wilkinson, Gaddis & Co.	Newark	31.83	32	7.28	5	31 00
1215	Vile & Sons	Jersey City	33.78	32	7.80	5	35 00
1219	A. Hannibal	Hoboken	32.41	32	6.75	5	30 00
1286	Nischwitz & Kitchen	Plainfield	31.60	32	7.00	5	40 00
1377	S. L. Pancoast	Mullica Hill	29.54	32	8.89	5	35 00
1120	J. L. Hance	Hackettstown	35.54	32	6.73	5	30 00
1326	L. B. Risdon	Trenton	29.89	32	7.36	5	30 00
1268	Jos. Benedict	Elizabeth	32.86	32	6.58	5	32 00
1196	J. C. Smith & Wallace Co	Newark	32.74	32	6.91	5	30 00
1216	Carscallen & Cassidy	Jersey City	35.15	32	8.08	5	36 00
1217	Long Dock Mills and Elevator	Jersey City	30.34	32	8.39	5	27 00
1218	Hanks & Co.	Jersey City	31.26	32	8.53	5	....
1254	Jaqui & Co.	Morristown	32.98	32	6.54	5	34 00
1303	Mundy Bros	Bound Brook	31.94	32	7.17	5	34 00
1288	R. F. Hohenstein	Westfield	31.83	32	7.25	5	40 00
1306	P. J. Staats	Bound Brook	32.52	32	7.34	5	31 00
1447	C. W. Russell	New Brunswick	33.18	32	7.66	5	35 00
1359	Samuel Anderson	Hammonton	36.76	32	9.75	5	35 00
1541	J. L. Hope	Madison	32.76	32	7.75	5	29 00
1349	J. S. Middleton	Camden	31.43	32	6.49	5	30 00
1147	Simmons & Martin	Deckertown	31.80	32	6.81	5	35 00
1178	P. O'Blenis	Paterson	31.59	32	7.09	5	32 00
1284	Meyer & De Vogel	Paterson	32.98	32	7.25	5	32 00
1396	Theo. Messinger	Egg Harbor City	33.86	32	7.61	5	35 00
1397	D. W. McClain	May's Landing	32.41	32	6.66	5	40 00
1398	J. C. Johnson	Hammonton	33.66	32	7.80	5	35 00
1399	E. Stockwell	Hammonton	31.66	32	6.61	5	35 00
1417	J. B. Rose & Son	Millville	31.38	32	6.90	5	35 00
1418	Mixner & Mickle	Bridgeton	34.24	32	7.41	5	35 00
1419	E. L. Langley & Co	Millville	32.89	32	6.92	5	*60 00
1420	Fithian & Pennell	Bridgeton	34.69	32	6.83	5	*55 00
1431	Vineland Grain Co	Vineland	31.60	32	6.69	5	32 00
1416	W. O. Garrison	Bridgeton	31.05	32	6.46	5	35 00
1408	J. K. Waddington	Salem	31.94	32	9.52	5	33 00
1500	Robt. Pearce & Sons	Red Bank	32.29	32	7.30	5	40 00
1487	J. S. Collins & Son	Moorestown	31.89	32	6.57	5	32 00
1518	L. E. Brown	Red Bank	32.85	32	8.21	5	30 00
1519	R Hance	Red Bank	32.29	32	7.28	5	33 00

*Omitted from the average.

I. PROTEIN FEEDS.

2. Linseed Meal, Oil Meal or Cake Meal.—Con.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	American Linseed Co., Chicago, Ill.—Con.		%	%	%	%	
1520	Petty & Applegate	Perth Amboy	32.18	32	6.98	5	$40 00
1228	Miller & Bertholf	Jersey City	35.04	32	7.45	5	30 00
1388	Geo. Elvins	Hammonton	36.76	32	9.55	5	34 00
	T. J. Preston, Newark, N. J.						
1284	C. Frank French	Plainfield	34.98	32	7.88	5	38 00
1205	A. Cyphers	Newark	35.49	32	7.85	5	32 00
1206	Drake & Co	Newark	36.58	32	6.58	5	32 00
1256	The Paul T. Norton Co	Elizabeth	35.78	32	6.58	5	32 00
1285	A. L. Cadmus	Plainfield	32.41	32	12.41	5	36 00
1276	Van Zandt & Voorhees	Plainfield	35.15	32	7.69	5	35 00
1283	The Paul T. Norton Co	Plainfield	35.73	32	6.23	5	32 00
1499	C. H. Snyder & Son	Freehold	35.16	32	7.24	5	36 00
1515	The Paul T. Norton Co	Red Bank	34.48	32	7.87	5	33 00
	Sharpless & Bro., Camden, N. J.						
1388	Sharpless & Bro	Camden	37.88	....	6.90	......	31 00
1392	G. Ripley	May's Landing	37.67	....	6.78	......	40 00
1428	J. J. Hunt	Vineland	36.29	....	11.49	......	34 00
1429	M. E. Lush	Vineland	36.58	....	7.09	......	36 00
1496	Colkitt & Thomson	Mount Holly	37.24	....	6.56	......	40 00
	Sitley & Son, Camden, N. J.						
1345	Sitley & Son	Camden	35.78	32	9.49	5	28 75
1391	Chas. Cast	Egg Harbor City	37.79	32	6.92	5	35 00
1435	D. W. Rodan	Cape May City	27.56	32	8.59	5	*50 00
	Titus, Wells & Willis, N. Y. City.						
1282	Wm. Veldran & Sons	Oradell	28.74	....	6.71	......	37 00
	Hauenstein & Co., Buffalo, N. Y.						
1297	R. B. Beatty	North Branch	37.83	40.96	8.07	8.65	34 00
	W. S. Woodward, Philadelphia, Pa.						
1383	H. A. Fish	Woodbury	35.49	....	6.00	......	40 00
	Manufacturer Unknown.						
1262	C. Pountney	Elizabeth	28.70	....	5.58	......	....
1280	Wm. Lunger	Plainfield	35.49	....	7.01	......	38 00
1324	J. E. Stevenson Co.	Trenton	33.78	....	7.27	......	30 00
1443	T. C. Dugan	New Brunswick	32.06	....	7.29	.....	35 00
1509	Thos. Eggert & Co	Perth Amboy	33.19	....	9.04	......	35 00
		Average	33.30	....	7.49	.....	34 08

*Omitted from the average.

I. PROTEIN FEEDS.

3. Flaxseed Meal.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
			%	%	%	%	
1816	Allen & Stults	Trenton	25.25	....	37.43	.....	....
1828	J. E. Stevenson Co.	Trenton	28.82	....	37.00	.....	....
1843	Sharpless & Bro.	Camden	24.89	....	37.52	.....	$80 00
1850	Taylor Bros.	Camden	*18.15	....	*25.48	.....	100 00
1895	Wm Heald Co.	Atlantic City	24.84	....	37.64	.....	140 00
1846	Sitley & Son	Camden	*17.75	....	*25.12	.....	75 00
1436	D. W. Rodan	Cape May City	*19.35	....	*26.03	.....	100 00
		Average	24.58	....	37.40	.....	....

4. Chicago Gluten Meal.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co., Chicago, Ill.						
1018	R. J. Kimble	Monroe	35.43	39.50	6.13	3.37	25 50
1040	R. V. Northrup	Augusta	38.95	39.00	2.50	3.37	26 50
1041	A. N. Roe	Branchville	37.03	36.00	3.75	3.37	26 50
1832	Sitley & Son	Camden	38.81	38.00	4.07	3.30	25 00
1855	Taylor Bros.	Camden	37.67	38.00	3.15	3.30	26 00
1485	W. D. Rogers & Co.	Moorestown	37.69	39.50	3.83	3.37	27 00
		Average	37.60	....	3.91	.....	26 08

5. Davenport Gluten Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co.						
1107	J. A. Wintermute	Middleville	24.44	27.83	3.78	2.96	20 60
1152	A. D. Cornell	Stillwater	21.71	27.83	4.18	2.96	22 00
1548	Chas. Wright	Columbus	24.01	28.00	3.29	......	19 50
		Average	24.39	....	3.75	......	20 70

6. Waukegan Gluten Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	U. S. Sugar Refining Co., Waukegan, Ill.						
1048	A. N. Roe	Branchville	26.36	27.88	4.31	3.39	21 50

*Omitted from average.

I. PROTEIN FEEDS.

7. Buffalo Gluten Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co., Chicago, Ill.		%	%	%	%	
1068	C. T. Mott & Co	Vernon	26.04	27.00	8.49	8.00	$21 00
1069	Stephen Roy	Glenwood	27.48	27.00	8.18	8.00	21 00
1018	R. J. Kimble	Monroe	26.89	28.00	2.86	8.00	21 00
1169	R. Corsen	Blair	27.43	....	2.89	.....	21 00
1333	Sitley & Son	Camden	26.68	28.00	4.25	8.80	20 00
1380	C. H. Kirby	Medford	26.84	....	8.26	.....	21 00
1381	S L. Pancoast	Mullica Hill	26.84	28.00	8.17	2.00	21 00
1382	C. C. Turner	Penn's Grove	28.86	28.00	8.08	8.80	22 00
1391	Chas. Cast	Egg Harbor City	26.56	27.50	8.54	8.00	25 00
1410	W. O. Garrison	Bridgeton	26.85	27.50	4.00	8.80	28 00
1412	Mixner & Mickle	Bridgeton	26.62	....	4.10	.....	28 00
1433	W. D. Rogers & Co	Moorestown	25.8	27.50	4.10	8.00	22 00
1354	Taylor Bros	Camden	26.89	27.50	8.46	8.80	20 50
1390	G. Elvins	Hammonton	26.82	28.00	8.60	8.80	24 40
1405	J. K. Waddington	Salem	26.49	....	4.46	.....	21 00
1413	Fithian & Pennell	Bridgeton	28.18	27.50	4.10	8.00	28 00
		Average	26.51	....	3.60	.....	21 87

8. Rockford Diamond Gluten Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co.						
1062	W. H Ingersoll	Hamburg	26.89	27.00	8.95	3.00	20 50
1153	R. Harden	Hamburg	27.64	27.00	8.58	3.00	20 80
1221	Long Dock Mills and Elevator	Jersey City	27.31	26.20	2.68	2.70	....
1246	Jaqui & Co	Morristown	27.48	27.00	8.25	8.00	22 00
		Average	27.32	....	3.34	.....	21 10

9. Marshalltown Gluten Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co.						
1247	Jaqui & Co	Morristown	29.20	27.00	8.44	8.00	22 00

10. Other Gluten Feeds.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Selling Price per Ton.
	Glucose Sugar Refining Co.						
1265	The Paul T. Norton Co	Rahway	22.79	....	2.38	.....	....
	National Starch Mfg. Co., N. Y. City.						
1322	L. B. Risdon	Trenton	28.74	28.40	4.42	4.80	22 00
1319	L. B. Risdon	Trenton	29.89	....	8.63	.....	22 00
1236	Meyer & De Vogel	Paterson	26.11	....	4.23	.....	22 00
1314	Allen & Stults	Trenton	24.50	....	5.68	.....	22 00
1327	J. E. Stevenson Co.	Trenton	22.10	....	8.00	.....	22 00
1033	R. V. Northrup	Augusta	20.12	21.20	2.58	2.90	21 00
1517	Thos. Eggert & Co	Perth Amboy	29.70	....	4.23	.....	22 00
		Average	25.88	....	3.96	.....	21 86
	Manufacturer Unknown.						
1340	Sharpless & Bro	Camden	25.65	....	5.89	.....	21 00

I. PROTEIN FEEDS.

11. Dried Brewers' Grains.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Selling Price per Ton.
	E. P. Mueller, Chicago, Ill.		%	%	%	%	
1078	A. Emmons	Halsey	26.58	23.85	7 22	6.18	$18 00
1162	C. A. Wilson & Co	Deckertown	26.51	23.85	7.91	6.18	19 00
1261	Kynor & Looker	Boonton	26.79	23.85	7.8.	6.18	19 60
1444	T. C. Dugan	New Brunswick	25.71	23.85	7.89	6.18	19 00
	Gottfried Krueger Brewing Co., Newark, N. J.						
1523	Sent by College Farm	New Brunswick	25.59	23.71	9.24	7.80	17 60
	P. C. Kamm & Co., Milwaukee, Wis.						
1068	Hopkins & Williams	Deckertown	26.58	....	7.60	......	19 00
1185	J. A. Lydecker	Paterson	27.82	....	7.39	......	20 00
	Alfred Meurer Co., Milwaukee, Wis.						
1094	D. B. Keyser	Vail	29.24	25.81	7.12	7.20	19 00
	J. C. Klauder, Philadelphia, Pa.						
1342	Sharpless & Bro	Camden	23.41	31.63	9.16	6.34	18 50
1374	Taylor Bros	Camden	22.59	31.63	7.95	6.34	19 00
1433	Vineland Grain Co	Vineland	26.56	31.00	7.21	6.00	21 00
1481	Hopkins & Lippincott	Moorestown	22.16	31.63	7.00	6.34	18 00
1497	Colkitt & Thomson	Mount Holly	21.49	31.63	6.90	6.34	20 00
	Manufacturer Unknown.						
1415	C. W. Russell	New Brunswick	26.33	....	7.64	......	18 75
1473	J. S. Collins & Son	Moorestown	26.66	....	8.00	......	19 50
		Average	25.57	....	7.74	......	19 06

12. Malt Sprouts.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Selling Price per Ton.
	E. P. Mueller, Chicago, Ill.						
1074	C. T. Mott & Co	Vernon	25.19	26.25	2.27	1.01	17 00
1259	Kynor & Looker	Boonton	27.94	26.25	2.37	1.01	18 00
1054	Stephen Roy	Glenwood	24.54	26.25	3.09	1.01	17 00
1321	J. H. Ashton	Trenton	27.14	26.25	2.72	1.01	17 00
1070	E. A. Carpenter	Baleville	27.82	26.25	2.13	1.01	16 75
1186	J. A. Lydecker	Paterson	28.90	26.25	2.12	1.01	19 00
	Gottfried Krueger Brewing Co., Newark, N. J.						
1514	Sent by manufacturer	Factory	24 98	....	8.50	......	....
	M. G. Rankin & Co., Chicago, Ill.						
1022	Hopkins & Williams Co	Newton	25.19	26.25	3.06	1.01	17 50
1076	A. Emmons	Halsey	24.12	....	2.32	......	18 00
1093	D. B. Keyser	Vail	25.88	24.80	1.93	1.70	17 00
	John Rankin & Co., Chicago, Ill.						
1164	C. A. Wilson & Co	Deckertown	24.39	24.00	1.57	......	18 00
	Hottelet & Co., Milwaukee, Wis.						
1089	A. B. Albert	Danville	23.91	28.96	2.20	1.66	17 50
1159	Simmons & Martin	Deckertown	24.28	28.96	2.90	1.66	17 50
	American Malting Co., Buffalo, N. Y.						
1031	A. N. Roe	Branchville	26.79	....	1.44	......	17 50
	M. F. Barringer, Philadelphia, Pa.						
1133	R. Corsen	Blair	23.05	....	3.70	......	17 00

I. PROTEIN FEEDS.

12. Malt Sprouts.—Con.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Arthur J. Clapp, N. Y. City.		%	%	%	%	%	
1017	B. K. Hopkins	Lafayette	22.79	....	2.28	....	....	$17 00
	F. K. Fish, New York City.							
1182	Meyer & DeVogel	Paterson	24.65	10.00	3.30	0.50	....	18 00
	F. W. Goeke & Co., St. Louis, Mo.							
1011	J. B. Wintermute	Newton	26.58	24.80	3.19	1.70	....	17 75
	Henry Rang & Co., Chicago, Ill.							
1323	J. E. Stevenson Co.	Trenton	25.88	....	2.62	....	....	18 00
	Manufacturer Unknown.							
1163	W. R. Morris	Fredon	24.28	....	3.33	....	....	17 50
1176	*P. O'Blenis	Paterson	27.48	....	2.84	....	....	18 00
1347	Sitley & Son	Camden	30.23	25.19	2.24	0.67	....	17 00
1370	Taylor Bros	Camden	23.01	25.19	2.96	0.67	....	17 00
		Average	25.59	....	2.59	....	....	17 50

13. Wheat Feeds.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co.'s Buckeye Feed.							
1008	S. S. Wills	Andover	17.50	16.21	4.22	4.48	5.06	20 00
1027	S. Hill	Newton	16.70	16.21	4.49	4.48	5.64	20 00
1170	T. Brown	New Foundland	17.18	16.21	4.75	4.48	7.13	21 00
		Average	17.13	....	4.49	....	5.94	20 33
	Harter's Mixed Feed.							
1158	R. Harden	Hamburg	16.44	....	4.39	....	7.60	19 00
	National Milling Co.'s Mixed Feed.							
1136	R. Harden	Hamburg	17.02	....	4.62	....	8.34	19 00
	Rankin's Wheat Feed.							
1047	A. N. Roe	Branchville	17.29	....	4.37	....	5.86	19 00
	Hoosier Mill Feed.							
1451	Henry Banker	New Brunswick	18.39	....	4.70	....	7.07	20 00
	Wheat Bran.							
1378	Barber & Turner (Winter)	Penn's Grove	17.86	....	4.20	....	6.70	20 00
1006	W. H. Ingersoll	Hamburg	15.74	....	4.67	....	9.01	18 50
1368	C. H. Kirby (Spring)	Medford	16.48	....	5.03	....	10.41	21 00
1365	Taylor Bros. (Spring)	Camden	16.26	....	5.18	....	9.74	20 50
1366	Taylor Bros. (Winter)	Camden	17.18	....	4.66	....	7.20	21 00
1387	Chas. Cast	Egg Harbor City	16.88	....	5.10	....	8.59	24 00

*Later reported as product of Lake Ontario Malting Co., Oswego, N. Y.

I. PROTEIN FEEDS.

13. Wheat Feeds.—Con.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Wheat Bran.—Con.		%	%	%	%	%	
1418	Runyon Bros.	New Brunswick	16.99	....	4.74	....	6.71	$20 00
1446	C. W. Russell	New Brunswick	16.65	....	5.11	....	10.97	19 00
1458	L. L. Holcombe	Flemington	16.76	....	5.28	....	9.16	19 00
1459	H. A. Ford (Spring)	Allentown	15.86	....	4.99	....	10.28	21 00
1460	H. A. Ford (Winter)	Allentown	18.78	....	4.48	....	7.92	21 00
1480	W. D. Rogers & Co. (Winter)	Moorestown	17.66	....	4.64	....	7.99	21 00
1491	Colkitt & Thomson (Spring)	Mount Holly	16.81	....	5.17	....	9.72	21 00
1505	T. A. Ward	Freehold	17.78	....	4.58	....	8.05	24 00
1508	J. P. Wyckoff (Winter)	Manasquan	18.68	....	4.86	....	6.46	24 00
1518	Petty & Applegate (Winter)	Perth Amboy	15.75	....	4.49	....	9.00	23 00
		Average	16.63	....	4.78	....	8.62	21 15
	Ship Stuff.							
1055	C. G. Clark & Co.	Westown	16.83	....	4.25	....	6.84	18 00
1161	C. A. Wilson & Co.	Deckertown	17.41	....	4.81	....	6.70	19 00
		Average	17.12	....	4.28	....	6.77	18 50

14. H. O. Dairy Feed.

	The H. O. Co., Buffalo, N. Y.							
1204	A. Cyphers	Newark	19.69	18.00	8.95	4.50	13.12	25 00
1258	Jos. Benedict	Elizabeth	19.29	18.00	8.76	4.50	12.01	23 00
1300	Mundy Bros.	Bound Brook	17.81	18.00	8.80	4.50	12.36	22 00
1320	L. B. Risdon	Trenton	17.12	18.00	8.98	4.50	12.95	22 00
1357	C. H. Kirby	Medford	18.21	18.00	8.78	4.50	13.32	21 50
		Average	18.42	....	8.85	....	12.75	22 70

15. Miscellaneous.

	Sucrene Dairy Feed, American Milling Co.							
1402	J. K. Waddington	Salem	21.75	16.50	6.90	3.50	8.96	21 00
	Germ Oil Meal, Cerealine Mfg. Co.							
1141	C. A. Wilson & Co.	Deckertown	16.11	....	8.40	....	....	25 00
1472	W. D. Rogers & Co.	Moorestown	17.66	....	9.20	....	....	22 00
1474	J. S. Collins & Son	Moorestown	14.79	....	12.79	....	....	22 00
1476	Hopkins & Lippincott	Moorestown	16.59	....	8.22	....	....	22 00
		Average	16.29	....	9.65	....	....	22 75

II. CARBOHYDRATE FEEDS.

1. Hominy Meal or Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.		%	%	%	%	%	
1029	S. Hill	Newton	10.83	10.74	7.89	6.20	....	$20 00
	American Malting Co., Detroit, Mich.							
1066	E. A. Carpenter	Baleville	10.78	9.89	8.47	7.06	....	18 50
	M. F. Barringer, Philadelphia, Pa.							
1134	W. R. Morris (White)	Fredon	11.10	....	8.41	....	....	19 00
1135	W. R. Morris (Yellow)	Fredon	12.11	....	8.88	....	....	19 00
1064	R. V. Northrup	Augusta	11.21	....	9.14	....	....	19 00
	Columbia Flour and Grain Co., Newark, N. J.							
1065	A. N. Roe	Branchville	*7.90	....	*5.70	....	11.86	18 00
	Chapin & Co., St. Louis, Mo.							
1058	W. H. Ingersoll	Hamburg	10.85	11.00	8.88	8.00	....	18 00
	F. K. Fish, New York City.							
1181	P. O'Blenis	Paterson	10.58	7.00	7.59	5.00	....	19 00
	The Hudnut Co., Terre Haute, Ind.							
1060	Stephen Roy	Glenwood	10.89	12.85	8.68	8.52	....	18 00
	Indianapolis Hominy Mills, Indianapolis, Ind.							
1042	C. T. Mott & Co.	Vernon	11.10	11.64	8.52	8.08	....	20 00
1028	G. O. Young	Andover	10.68	11.10	9.81	10.47	....	18 00
	J. S. Lapham & Co., Detroit, Mich.							
1190	D. C. Hallet	Stillwater	10.85	10.15	8.48	6.68	....	18 40
	G. Q. Moon & Co., Binghamton, N. Y.							
1044	J. C. Ellett	Branchville	10.78	....	8.60	....	....	19 00
	Shellabarger Milling and Elevator Co., Decatur, Ill.							
1180	Simmons & Martin	Deckertown	10.56	10.76	8.90	8.64	....	19 00
1189	J. English	Paterson	11.21	11.14	9.80	9.02	....	20 00
	Simpson, Hendee & Co., New York City.							
1192	J. English	Paterson	9.50	9.89	6.74	7.06	....	20 00
1250	Jaqui & Co.	Morristown	12.08	....	10.17	....	....	20 00
	Suffern, Hunt & Co., Decatur, Ill.							
1166	R. Corsen	Blair	11.86	11.02	8.97	7.77	....	20 00
	M. M. Wright & Co., Danville, Ill.							
1167	A. D. Cornell	Stillwater	10.14	10.93	8.65	8.00	....	19 00
	Manufacturer Unknown.							
1229	Holly & Smith	Hackensack	10.18	....	7.17	....	....	....
		Average	10.85	....	8.59	....	....	19 05

* Not included in average.

II. CARBOHYDRATE FEEDS.

2. Quaker Dairy Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.		%	%	%	%	%	
1001	S. S. Wills	Andover	12.06	12.03	2.88	2.50	17.99	$18 00
1026	S. Hill	Newton	12.70	12.03	3.88	2.50	15.66	18 00
1099	W. Beatty	Hainesburg	13.05	12.03	3.05	2.50	16.95	18 00
1224	J. J. Bell	New Milford	13.41	12.03	3.50	2.50	18.63	....
1376	H. A. Fish	Woodbury	13.11	12.03	3.01	2.50	20.82	19 00
1268	Nischwitz & Kitchen	Plainfield	15.11	12.03	3.21	2.50	15.80	20 00
1309	J. E. Stevenson Co.	Trenton	12.59	12.03	3.15	2.50	17.88	20 00
1464	W. D. Rogers & Co.	Moorestown	13.50	12.03	3.56	2.50	17.90	19 00
		Average	13.19	....	3.22	....	17.64	18 86

3. Victor Corn and Oat Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein Found.	Protein Guaranteed.	Fat Found.	Fat Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.							
1010	G. O. Young	Andover	9.44	8.23	4.02	3.00	9.75	18 00
1004	Hopkins & Williams Co.	Newton	8.96	8.23	4.19	3.00	9.16	17
1218	A. Hannibal	Hoboken	7.61	8.23	3.24	3.00	13.28	20 00
1225	J. J. Bell	New Milford	8.59	8.23	4.86	3.00	12.06	....
1463	W. D. Rogers & Co.	Moorestown	9.45	8.23	4.56	3.00	6.6[illegible]	19 00
1267	A. L. Cadmus	Plainfield	8.36	8.23	4.21	3.00	12.40	18 00
1289	Mundy Bros	Bound Brook	8.48	8.23	4.21	3.00	11.61	19 00
1312	J. H. Ashton	Trenton	8.48	8.23	4.47	3.00	11.37	18 00
1127	Simmons & Martin	Deckertown	9.00	8.23	4.17	3.00	12.01	17 00
1212	Hanks & Co.	Jersey City	8.21	8.23	3.80	3.00	10.92	....
1214	Miller & Bertholf	Jersey City	8.21	8.23	3.69	3.00	10.61	19 00
1266	Nischwitz & Kitchen	Plainfield	10.01	8.23	3.67	3.00	9.87	20 00
		Average	8.73	....	4.09	....	10.80	18 55

4. Corn, Oat and Barley Feed (Schumacher Stock Feed).

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein Found.	Protein Guaranteed.	Fat Found.	Fat Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.							
1009	G. O. Young	Andover	11.42	10.79	4.69	3.29	11.14	20 00
1129	C. A. Wilson & Co.	Deckertown	11.34	10.79	4.53	3.29	11.80	20 00
		Average	11.38	....	4.61	....	11.47	20 00

II. CARBOHYDRATE FEEDS.

5. H. O. Horse Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	The H. O. Co., Buffalo, N. Y.		%	%	%	%	%	
1202	Drake & Co	Newark	12.71	12.00	4.18	4.50	9.60	$22 00
1222	Vile & Sons	Jersey City	12.03	12.00	3.82	4.50	9.33	22 00
1251	Jos. Benedict	Elizabeth	12.37	12.00	3.76	4.50	8.98	23 00
1358	C. H. Kirby	Medford	12.71	12.00	3.82	4.50	10.65	21 00
1299	Mundy Bros	Bound Brook	12.48	12.00	4.05	4.50	10.18	21 00
1336	J. S. Middleton	Camden	12.71	12.00	3.86	4.50	9.51	22 00
1479	W. D. Rogers & Co	Moorestown	12.60	12.00	3.86	4.50	9.44	22 00
1450	Runyon Bros	New Brunswick	13.28	12.00	4.35	4 50	9.33	22 00
		Average	12.61	....	3.89	....	9.63	21 88

6. Corn Bran or Sugar Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Glucose Sugar Refining Co., Chicago, Ill.							
1014	Hopkins & Williams Co	Newton	13.29	13.50	3.44	3.70	12.26	17 00
1024	G O. Young	Andover	13.98	13.50	3.03	3.70	12.01	15 00
1086	D. B. Keyser	Vail	13.34	13.50	3.22	3.70	11.94	16 50
1364	C. H. Kirby	Medford	13.63	13.50	3.63	3.70	10.91	18 00
1404	J. K. Waddington	Salem	12.54	13.50	3.82	3.70	12.89	19 00
		Average	13.36	....	3.44	....	12.00	17 10
	John Rankin & Co., Chicago, Ill.							
1089	C. T. Mott & Co	Vernon	9.29	9.19	3.54	4.55	13.71	17 00
	Wm. T. Reynolds & Co., Poughkeepsie, N. Y.							
1165	C. A. Wilson & Co	Deckertown	8.75	9.44	4.80	1.60	13.71	16 00
	Chas. Pope Glucose Co., Chicago, Ill.							
1050	E. A. Carpenter	Baleville	10.68	11.75	4.29	5.00	14.74	16 50
	Taylor Bros., Camden, N. J.							
1375	Taylor Bros	Camden	9.22	....	4.65	....	7.92	19 00
1371	Taylor Bros	Camden	8.76	10.31	3.08	1.78	9.89	17 00
1415	W. O. Garrison	Bridgeton	11.22	10.31	3.22	1.78	13.80	22 00
1476	Hopkins & Lippincott	Moorestown	9.90	....	7.70	....	14.16	16 00
		Average	9.69	....	5.18	....	12.49	17 64

II. CARBOHYDRATE FEEDS.

7. Cerealine Feeds.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Cerealine Mfg. Co., Indianapolis, Ind.		%	%	%	%	%	
1012	Hart & Iliff	Newton	11.58	18.19	8.74	6.07	....	$19 00
1082	McDanolds & Lance	Branchville	10.56	14.00	7.24	7.29	....	19 00
1187	Reeve Harden	Hamburg	9.91	18.19	7.22	6.07	....	20 00
1188	Simmons & Martin	Deckertown	10.59	14.00	7.08	7.29	....	20 00
1881	Sitley & Son	Camden	11.84	10.82	8.52	7.57	....	18 50
1469	W. D. Rogers & Co	Moorestown	7.59	7.88	5.26	5.45	....	21 00
1470	J. S. Collins & Son	Moorestown	7.81	7.88	5.22	5.45	....	20 00
1471	Hopkins & Lippincott	Moorestown	7.54	7.85	5.78	5.45	....	20 50
		Average	9.55	....	6.88	....	....	19 75

8. Horse Feeds (Not Made from Whole Grains).

Sample Number.	Manufacturer or Jobber and Dealer.	*Ingredients.*	Protein Found.	Protein Guaranteed.	Fat Found.	Fat Guaranteed.	Crude Fiber.	Selling Price per Ton.
1082	Belvidere Flour Mill Co.. Belvidere, N. J.	Rye bran and middlings, corn, oats, corn ears and Vim Oat Feed,	10.68	....	8.69	....	5.25	18 00
1175	P. O'Blenis, Paterson, N. J.	Hominy, oat feed, corn and middlings	11.56	....	5.82	....	9.79	20 00
1015	A. D. Cornell, Stillwater, N. J.	Oats, hominy and wheat bran	11.11	....	6.28	....	5.80	28 00
1086	C. H. Crisman, Branchville, N. J.	Corn, rye, oats, wheat bran and buckwheat middlings	11.21	....	8.98	....	3.29	22 00
1088	Luther Emery, Portland, Pa. (Albertson & Davison, Columbia, N. J.)	Corn, rye and wheat bran	8.96	....	2.70	....	1.96	22 00
1180	Joseph English, Paterson, N. J.	Hominy, oat chop and rye middlings	10.68	....	7.24	....	8.79	20 00
1157	Reeve Harden, Hamburg, N. J.	Cerealine feed No. 2, oats, wheat bran and rye middlings	12.25	....	6.05	....	4.88	22 00
1064	W. H. Ingersoll, Hamburg, N. J. (Hercules)	Hominy, oats, wheat or rye middlings and buckwheat middlings	18.77	10.00	6.88	5.00	4.92	22 00
1067	W. H. Ingersoll, Hamburg, N. J. (Utility)	....	10.56	10.00	5.88	4.50	6.00	20 00

II. CARBOHYDRATE FEEDS.

8. Horse Feeds (Not Made from Whole Grains)—Con.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN.		FAT.		Crude Fiber.	Selling Price per Ton.
			Found.	Guaranteed.	Found.	Guaranteed.		
		Ingredients.	%	%	%	%	%	
1249	Jaqui & Co., Morristown, N. J.	Hominy and Chester Stock Food	9.85	....	5.56	....	3.84	$21 00
1092	I. B. Keener, Belvidere, N. J.	Corn, oats, rye bran and middlings	10.62	....	3.81	....	2.85	18 00
1072	G. K. & O. H. McMurtrie, Belvidere, N. J.	Corn, oats, rye middlings and wheat screenings	9.71	10.00	3.45	3.00	5.39	23 00
1111	G. K. & O. H. McMurtrie, Belvidere, N. J.	Corn, oats, rye middlings and wheat screenings	10.81	10.00	3.15	3.00	4.19	22 00
1117	Pursel Mill and Coal Co., Phillipsburg, N. J.	Hominy, oat chop, corn and wheat bran	9.29	....	5.23	....	4.29	19 00
1304	P. J. Staats, Bound Brook, N. J.	Corn and oat feed,	8.98	....	3.81	....	4.85	21 00
1123	J. A. Wintermute, Middleville, N. J.	Corn, rye and hominy	9.90	....	5.24	....	3.87	20 00
1329	J. E. Stevenson Co., Trenton, N. J.	Corn, oats and bran	10.68	....	4.15	....	2.94	22 00
1315	Allen & Stults, Trenton, N. J.	Corn, oats and bran	10.59	....	4.19	....	4.96	20 00
1521	F. C. Williams, Easton, Pa.	No. 1	10.91	....	3.80	....	2.48	23 00
1522	F. C. Williams, Easton, Pa.	No. 2	10.01	....	4.98	....	4.01	20 00
1103	N. Dufford, Hackettstown, N. J. (City Feed)	Corn ears and oat tailings	8.01	....	3.61	....	6.72	16 00
1226	J. J. Bell, New Milford, N. J.	Victor, Quaker, corn, etc.	9.28	....	4.11	....	9.98	21 00
		Average	10.38	....	4.66	....	5.22	20 68

9. Chester Stock Food.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	Protein Found.	Protein Guaranteed.	Fat Found.	Fat Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Husted Mill and Elevator Co., Buffalo, N. Y. (A. J. Clapp, N. Y City, Agent.)							
1145	Simmons & Martin	Deckertown	7.26	11.50	3.12	4.20	12.15	18 00
1083	A. B. Albert	Danville	7.58	11.50	3.26	4.20	10.92	20 00
1227	Wm. Veldran & Sons	Oradell	7.44	11.50	3.38	4.20	12.39	19 00
1271	A. Gray & Co.	Dunellen	7.44	11.50	3.28	4.20	11.66	19 00
1020	J. B. Titman	Sparta	7.90	10.40	3.25	3.27	10.77	19 00
1144	C. A. Wilson & Co.	Deckertown	7.79	11.50	3.21	4.20	9.70	18 50
1245	Jaqui & Co.	Morristown	7.79	11.50	3.99	4.20	9.90	20 00
1272	A. L. Cadmus	Plainfield	7.10	11.50	3.15	4.20	10.45	18 00
1084	G. K. and O. H. McMurtrie	Belvidere	7.10	11.50	3.40	4.20	10.89	19 00
1061	E. A. Carpenter	Baleville	6.87	9.19	3.56	3.45	12.27	17 00
		Average	7.43	....	3.56	....	11.11	18 75

II. CARBOHYDRATE FEEDS.

10. Friend's Concentrated Dairy Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Muscatine Oat Meal Co., Muscatine, Iowa.		%	%	%	%	%	
1021	E. J. Hardin	Allamuchy	7.15	10.70	3.13	3.70	22.47	$16 00
1016	Hopkins & Williams Co	Newton	7.68	10.70	3.19	3.70	22.12	16 50
1337	Sharpless & Bro	Camden	8.64	10.70	3.88	3.70	20.28	15 00
1495	Colkitt & Thomson	Mount Holly	8.41	10.70	3.35	3.70	23.85	17 00
		Average	7.98	....	3.39	....	22.18	16 13

11. Other Dairy Feeds.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
1360	C. H. Kirby	Medford	12.48	....	3.24	....	5.29	18 50
1372	Taylor Bros. (No. 2)	Camden	11.11	12.62	3.53	3.06	8.62	16 00
1432	Taylor Bros. (No. 2)	Camden	10.48	12.00	3.54	2.75	10.78	19 00
1079	Warren Beatty	Hainesburg	7.47	....	3.84	....	6.88	17 00
1187	J. A. Lydecker	Paterson	10.51	....	7.42	....	7.33	20 00
1208	J. C. Smith & Wallace Co	Newark	12.31	12.00	5.00	5.00	6.06	19 00

12. Oat Feeds.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Amer. Cereal Co.'s Vim Feed.							
1005	Hopkins & Williams Co	Newton	6.56	6.30	2.39	2.58	25.10	14 50
1171	Joseph English	Paterson	6.87	6.30	2.57	2.58	26.63	15 00
1240	Jaqui & Co	Morristown	5.84	6.30	2.23	2.58	28.40	16 00
1352	C. H. Kirby	Medford	4.53	6.30	2.06	2.58	28.96	17 00
1290	P. J. Staats	Bound Brook	4.01	6.30	1.49	2.58	31.23	18 00
1283	Meyer & DeVogel	Paterson	6.02	6.30	2.37	2.58	28.00	....
		Average	5.64	....	2.19	....	28.05	16 10
	Akron Cereal Co.'s Royal Feed.							
1124	A. D. Cornell	Stillwater	7.36	8.25	3.76	4.14	22.71	16 00
1318	J. H. Ashton	Trenton	7.27	8.25	3.24	4.14	22.78	16 00
	A. E. Howe's Oat Chop.							
1183	Joseph English	Paterson	2.61	3.58	1.22	1.27	32.07	15 00
	F. K. Fish's Oat Chop.							
1063	W. H. Ingersoll	Hamburg	2.46	1.00	0.91	1.00	32.22	15 00
1218	Joseph Benedict	Elizabeth	2.98	1.00	1.11	1.00	31.58	17 00
	Manufacturer Unknown.							
1378	Taylor Bros	Camden	7.79	8.75	3.24	2.56	21.58	15 00
1344	Sitley & Son	Camden	3.82	8.75	1.20	2.56	31.42	14 50
1389	Sharpless & Bro	Camden	2.46	....	1.03	....	32.41	....

II. CARBOHYDRATE FEEDS.

13. De Fi Corn and Oat Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Elsworth & Co., Buffalo, N. Y.		%	%	%	%	%	
1403	J. K. Waddington	Salem	8.70	8.80	8.18	8.00	14.89	$19 00

14. Durham Corn and Oat Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	David Oliver, Joliet, Ill.							
1188	J. H. Blauvelt & Sons	Ridgewood	7.47	9.46	2.80	8.92	18.06	20 00

15. Miscellaneous Feeds.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	The Bennett & Millett Co., Gouverneur, N. Y.							
1174	Clover Meal. P. O'Blenis	Paterson	5.76	....	8.88	....	29.21	40 00
	Miner Hilliard Mill Co., Wilkesbarre, Pa.							
1280	Star Chop. F. C. Dunn	Hackensack	7.79	7.75	4.56	4.00	11.86	20 00
	E. P. Mueller, Chicago, Ill.							
1260	Sugar Beet Feed. Kyner & Looker	Boonton	8.24	10.77	0.83	1.16	19.15	15 00
	American Cereal Co., Chicago, Ill.							
1429	Hulled Oats. T. C. Dugan	New Brunswick	16.20	....	7.57	....	....	30 00
	The Hudnut Co., Terre Haute, Ind.							
1351	Maizeline. Sitley & Son	Camden	10.42	10.00	9.08	8.86	6.81	19 50
1369	Ground Oats. Taylor Bros	Camden	10.02	....	4.88	....	18.92	25 00
1511	Barley Meal. Thos. Eggert & Co	Perth Amboy	13.84	....	4.60	....	12.79	22 00
1045	Corn Meal. J. C. Ellett	Branchville	9.07	....	4.80	....	....	22 00
1104	*Cracked Corn. N. Dufford	Hackettstown	9.29	....	3.37	....	....	22 00
1207	Yellow Feed J. C. Smith & Wallace Co	Newark	7.79	7.50	3.89	3.00	7.69	19 00
1210	Company Feed. Wilkinson, Gaddis & Co	Newark	10.19	....	4.29	....	3.95	19 50
1211	Mixed Feed. Wilkinson, Gaddis & Co	Newark	8.76	....	3.87	....	5.17	18 00
1118	Rice Feed Pursel Milling and Coal Co	Phillipsburg	11.15	....	8.85	....	....	17 00
1298	Rice Feed. John D. Hoffman	Lebanon	10.71	....	10.02	....	....	20 00
1307	Mixed Feed (Tolls) W. H. H. Wyckoff	Raritan	9.62	....	3.86	....	3.37	18 60
1361	Rye Bran. C. H. Kirby	Medford	13.28	....	2.68	....	2.61	17 50
1362	Rye Middlings. C. H. Kirby	Medford	8.82	....	1.81	....	1.22	18 00
1506	Rye Feed. T. A. Ward	Freehold	9.00	....	1.88	....	1.70	23 00

* One-fourth heart removed in cracking.

III. FEEDS MADE FROM WHOLE GRAINS.

1. Horse Feeds.

Sample Number.	MANUFACTURER AND PLACE OF SAMPLING.	Ingredients.	Protein.	Fat.	Crude Fiber.	Selling Price per Ton.
			%	%	%	
1298	G. N. Alpaugh, High Bridge	Corn, rye, oats	10.08	3.20	3.58	$21 00
1080	Warren Beatty, Hainesburg	Corn, rye, oats	9.61	3.48	4.68	22 00
1178	Belvidere Flour. Mill Co., Belvidere.	Corn, rye, oats	9.78	3.19	7.02	23 00
1149	*A. D. Cornell, Stillwater	Corn, rye, oats	9.82	3.18	3.79	22 00
1067	J. Crisman, Branchville	Corn, rye, oats	11.04	3.98	3.82	22 00
1087	G. H. Dorland, Blairstown	Corn, rye, oats	10.56	3.83	5.39	22 00
1102	Nelson Dufford, Hackettstown	Corn, rye, oats, corn ears	8.86	3.45	4.71	20 00
1088	†Eagle Flouring Mills, Ackermanville, Pa	Corn, rye, oats	9.93	3.55	4.60	22 00
1105	Geo. W. Fisher, Anderson	Corn, rye, oats	8.75	3.60	6.04	22 00
1274	‡Flemington Milling Co., Flemington	Oats, wheat	9.78	4.58	2.87	23 00
1090	E. J. Huff, Blairstown	Corn, rye, oats	9.29	2.78	3.72	22 00
1091	James Hutchinson, Delaware		10.46	4.16	2.75	20 00
1108	J. S. Hance, Hackettstown	Corn ears, rye, oats	8.75	2.88	7.92	22 00
1278	‡Higgins & Bros., Three Bridges	Corn, oats, wheat	10.18	4.28	2.68	23 00
1109	Wm. Larison, Washington	Corn ears, rye, oats	8.91	3.65	7.11	18 00
1048	McDanolds & Lance, Branchville	Corn, rye, oats	11.10	3.44	3.68	22 00
1112	Opdyke & Son, Washington	Corn ears, rye, oats	7.79	3.47	7.67	22 00
1116	Pursel Milling and Coal Co., Phillipsburg	Corn, rye, oats	11.42	4.71	4.02	22 00
1118	¶D. P. Reeves, New Hampton	Corn, rye, oats, corn ears	9.89	3.31	4.85	20 00
1096	W. H. Stires, Warrington	Corn ears, rye, oats	8.54	2.82	5.18	20 00
1119	S. Shillinger & Bro., Stewartsville	Corn, rye, oats	9.82	3.85	2.28	20 00
1198	J. C. Smith & Wallace Co., Newark	Corn, rye, oats	10.19	4.59	10.51	21 60
1264	††J. C. Smith & Wallace Co., Newark	Corn, rye, oats	8.78	3.47	7.66	21 60
1190	M. M. Simonson, Newark	Corn, rye, oats	9.10	3.95	5.56	20 00
1098	§H. D. White & Son, Beattystown	Corn, rye, oats	11.95	3.84	4.51	22 00
1122	**Saml. Wildrick, Townsbury	Corn ears, rye, oats	8.76	3.12	6.01	22 00
1384	Saml. Anderson, Hammonton	Corn, oats, wheat	10.99	4.82	5.02	25 00
		Average	9.76	3.63	5.09	21 56

* Stock of Fold Bros., Sparta.
† Stock of S. Hill, Newton.
‡ Stock of R. F. Hohenstein, Westfield.
¶ Stock of J. M. Fitts, Washington.
†† Stock of C. Pountney, Elizabeth.
§ Stock of A. B. Albert, Danville.
** Stock of Empire Steel and Iron Co., Oxford.

III. FEEDS MADE FROM WHOLE GRAINS.

2. Corn and Oats.

Sample Number.	MANUFACTURER.	Place of Sampling.	Protein.	Fat.	Crude Fiber.	Selling Price per Ton.
			%	%	%	
1286	M. H. Acken, Rahway	Rahway	10.08	4.14	3.61	$22 00
1291	W. N. Adair, Raritan	Raritan	10.25	4.29	3.53	20 00
1241	Amerman's Mills, South Branch	Elizabeth	9.62	4.39	3.67	20 00
1442	P. E. Apgar, Weston	New Brunswick	10.01	4.75	2.13	20 00
1449	Henry Banker, New Brunswick	New Brunswick	9.56	4.24	3.07	20 00
1295	R. B. Beatty, North Branch	North Branch	10.42	4.42	5.17	18 00
1296	*R. B. Beatty, North Pranch	North Branch	8.30	3.90	6.36	16 00
1270	A. L. Cadmus, Plainfield	Plainfield	8.70	3.68	5.26	20 00
1199	A. Cyphers, Newark	Newark	9.51	4.18	2.80	22 00
1510	Thos. Eggert & Co., Perth Amboy	Perth Amboy	9.51	4.47	2.55	22 00
1409	Fithian & Pennell, Bridgeton	Bridgeton	10.76	5.14	3.95	22 00
1278	Flemington Milling Co., Flemington	Plainfield	8.70	4.22	3.10	20 50
1458	H. A. Ford, Allentown	Allentown	10.69	4.78	3.94	21 00
1275	C. Frank French, Plainfield	Plainfield	8.53	4.27	1.66	21 00
1512	R. Hance, Red Bank	Red Bank	10.13	4.72	3.15	24 00
1455	Higgins & Bros., Three Bridges	Three Bridges	9.79	4.57	2.27	20 00
1456	L. L. Holcombe, Flemington	Flemington	9.51	4.77	3.38	20 00
1414	J. T. Johnson, Bridgeton	Bridgeton	11.28	5.12	3.94	24 00
1462	G. H. Kirby, Allentown	Allentown	10.35	4.84	3.25	21 00
1046	G. Q. Moon & Co., Binghamton, N. Y	Branchville	7.90	3.88	7.60	21 00
1301	*David Neff, North Branch	North Branch	9.84	4.67	4.88	20 00
1257	The Paul T. Norton Co., Elizabeth	Elizabeth	9.28	4.54	5.41	19 40
1457	A. Rockafellow, Flemington	Flemington	9.45	4.53	1.81	20 00
1348	Sitley & Son, Camden	Camden	11.51	5.90	5.93	21 00
1501	C. H. Snyder & Son, Freehold	Freehold	9.23	4.51	5.38	23 00
1400	Taylor Bros., Camden	Hammonton	10.42	4.57	6.22	26 00
1305	E. S. Van Derveer, North Branch Depot	No. Branch Depot	9.16	3.96	2.44	18 00
1287	Van Zandt & Voorhees, Plainfield	Plainfield	9.39	4.24	3.85	21 00
1424	Vineland Grain Co., Vineland	Vineland	10.42	4.80	5.24	22 00
1504	T. A. Ward, Freehold	Freehold	9.90	4.59	3.03	24 00
1097	*H. D. White & Son, Beattystown	Danville	7.50	3.31	6.20	18 00
1507	J. P. Wyckoff, Manasquan	Manasquan	10.46	4.60	3.03	22 00
		Average	9.69	4.47	3.99	20 90

* Corn ears and oats.

III. FEEDS MADE FROM WHOLE GRAINS.

3. Corn Ear or Cob Meal.

Sample Number.	MANUFACTURER.	Place of Sampling.	Protein.	Fat.	Crude Fiber.	Selling Price per Ton.
			%	%	%	
1292	G. N. Alpaugh	High Bridge	7.44	3.52	5.87	$14 00
1294	R. B. Beatty	North Branch	8.01	3.83	4.25	15 00
1081	Belvidere Flouring Mill Co	Belvidere	6.87	3.34	8.20	16 00
1148	A. D. Cornell	Stillwater	8.93	3.86	4.75	15 00
1085	Thomas Craig	Buttzville	6.87	2.52	5.62	16 00
1101	Nelson Dufford	Hackettstown	7.21	3.58	6.47	17 00
1065	W. H. Ingersoll	Hamburg	7.90	3.65	6.32	15 00
1859	C. H. Kirby	Medford	9.39	4.26	3.94	16 50
1110	Wm. Larison	Washington	7.27	3.49	8.20	13 50
1802	David Neff	North Branch	7.79	3.44	5.93	15 00
1808	W. H. H. Wyckoff	Raritan	7.33	3.72	5.39	16 50
		Average	7.73	3.52	5.90	15 41

IV. POULTRY, STOCK AND CONDIMENTAL FOODS.

1. H. O. Poultry Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	The H. O. Co., Buffalo, N. Y.		%	%	%	%	%	
1290	A. Cyphers	Newark	17.06	17.00	5.12	5.50	4.19	$30 00
1228	F. C. Dunn	Hackensack	17.18	17.00	5.92	5.50	5.08	35 00
1258	Jos. Benedict	Elizabeth	17.29	17.00	5.18	5.50	4.50	30 00
1295	J. S. Middleton	Camden	17.46	17.00	5.40	5.50	4.22	30 00
1311	J. E. Stevenson Co.	Trenton	16.94	17.00	5.89	5.50	4.87	30 00
1461	H. A. Ford	Allentown	18.00	17.00	5.82	5.50	5.48	29 00
1477	Hopkins & Lippincott	Moorestown	17.78	17.00	5.42	5.50	4.89	32 00
		Average	17.39	....	5.53	....	4.67	30 86

2. H. O. Scratching Feed.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	The H. O. Co., Buffalo, N. Y.							
1384	J. S. Middleton	Camden	12.25	....	4.65	....	....	35 00
1494	Colkitt & Thomson	Mount Holly	12.88	....	4.20	....	....	29 00

3. American Poultry Food.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.							
1128	C. A. Wilson & Co.	Deckertown	12.70	18.96	6.51	5.49	4.69	26 00
1440	C. W. Russell	New Brunswick	18.28	18.96	6.62	5.49	4.79	30 00

4. Other Poultry Feeds.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
1385	Old Fowl Mixture. Samuel Anderson	Hammonton	17.86	....	5.72	....	4.26	26 00
1489	Poultry Feed. Hopkins & Lippincott	Moorestown	18.23	....	9.11	....	7.46	30 00
1258	Poultry Feed. The Paul T. Norton Co.	Elizabeth	15.46	....	4.44	....	4.60	28 00
1546	Fidelity Food for Young Chicks. Pineland Incubator and Brooder Co	Jamesburg	19.85	20.47	6.67	8.68	....	....
1434	Wheat Screenings. W. Kimble	Rio Grande	12.94	....	5.89	....	4.12	18 00

5. Blatchford's Calf Meal.

Sample Number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	John W. Barwell, Waukegan, Ill.							
1189	C. A. Wilson & Co.	Deckertown	24.65	32.00	5.23	5.00	4.69	65 00
1242	Jos. Benedict	Elizabeth	25.08	32.00	5.42	5.00	4.94	70 00
1465	W. D. Rogers & Co.	Moorestown	24.98	32.00	5.22	5.00	4.36	70 00
		Average	24.90	....	5.29	....	4.66	68 33

IV. POULTRY, STOCK AND CONDIMENTAL FOODS.

6. American Calf Meal.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	American Cereal Co., Chicago, Ill.		%	%	%	%	%	
1130	C. A. Wilson & Co.	Deckertown	16.01	17.87	7.73	6.67	2.70	$32 00
1310	J. E. Stevenson Co.	Trenton	16.88	17.87	8.29	6.67	1.94	50 00
		Average	17.44	....	8.01	....	2.32	41 00

7. Banner Stock Food.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Banner Food Co., Auburn, N. Y.							
1588	Hart & Iliff	Newton	22.84	....	8.40	....	....	160 00

8. Baum's Horse and Stock Feed.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	Baum's Castorine Co., Syracuse, N. Y.							
1858	C. H. Kirby	Medford	24.84	....	‡9.20	....	18.82	200 00

9. Animal Meal.

Sample Number.	MANUFACTURER OR JOBBER AND DEALER.	Place of Sampling.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Crude Fiber.	Selling Price per Ton.
	The Bowker Co., Boston, Mass.							
1051	White Rock Lime and Cement Co.	McAfee	40.98	42.00	7.62	....	....	45 00
1248	Jos. Benedict	Elizabeth	48.05	80.00	8.52	5.00	....	45 00
1466	W. D. Rogers & Co.	Moorestown	42.18	....	8.79	....	....	50 00
1244	*Jos. Benedict	Elizabeth	58.59	80.00	14.92	20.00	....	50 00
	M. L. Shoemaker & Co., Philadelphia, Pa.							
1898	†Samuel Anderson	Hammonton	60.91	....	13.01	....	....	52 00

* Ground Beef Scrap.
† Ground Meat for Poultry.
‡ Ether extract, including much sulphur.

GUARANTEES.

The object of the law in requiring the collection and analysis of the samples of feeds which have been herein reported, is primarily to determine to what extent the law has been observed and wherein it has been violated. A survey of the entire lot of samples which have been collected for this inspection develops the fact that of the 529 received, 118 are not required by the law to be guaranteed; of the 411 remaining, 331 were found guaranteed or guarantees have been filed at the Experiment Station, 5 were accompanied by a mere statement of the ingredients and 75 were devoid of any tag, statement or information of any character.

Of the 469 samples which have been analysed, the law does not require a guarantee in the case of 111. Sixty-four of the remaining 358 have no guarantees, although in a number of the horse feeds the ingredients were given; and of the 289 samples which have guarantees, 174 only are substantially as guaranteed. To state the situation in another form, of the samples which the law requires to be guaranteed and which have been analysed, 17.9 per cent. are not guaranteed at all and only 48.6 per cent. are guaranteed correctly. An inspection of the tables develops the fact that of the 115 samples which fail to reach guarantee, 67 are deficient in protein, 28 in fat and 20 in both of these nutrients. There are, therefore, among the 289 guaranteed samples 87 instances of a deficiency in the most important constituent of a purchased feed. A more detailed review of the deficiencies follows.

I. PROTEIN FEEDS.

Cottonseed Meal.

The thirty-seven samples of cottonseed meal were with one exception accompanied by a guarantee, which guarantee was uniformly 43 per cent. of protein and 9 per cent. of fat. The actual composition of the samples analysed is far from showing the same uniformity, since it ranges in protein from about 5 per cent. below guarantee in sample No. 1467 to about 5½ per cent. above in sample No. 1379 (if we except No. 1542, containing 51.49 per cent., a sample from old stock which perhaps does not represent the product at the present time), and in fat from 3.38 per cent. above guarantee in sample No. 1467 to 1.28 per cent. below in sample No. 1052. Of the thirty-six samples with guarantees, No. 1172, one of the American Cotton Oil Company's

eleven samples; No. 1502, one of the fifteen samples of the "Cofco" (Cotton Oil & Fiber Company's) brand, and Nos. 1330, 1467 and 1468, or all of the samples of the "Owl" brand (F. W. Brode & Company) are below guarantee in protein. No. 1330 is not materially below, but it is low in fat also, whereas Nos. 1467 and 1468 are high in fat content. Of the remaining thirty-one samples above guarantee in protein, five are materially below in their content of fat. The sample without guarantee, No. 1544 (Sledge & Wells Company), is lower in protein than the guarantee of the others. The remaining twenty-six samples are excellent in this respect.

Linseed Meal.

Of the sixty-eight samples of linseed meal, the forty-three samples of the American Linseed Company's goods were all accompanied by the uniform guarantee of 32 per cent. of protein and 5 per cent. of fat. The guarantee of fat is exceeded in every case, but in seven samples the content of protein is deficient by more than one-half of one per cent.

Of the remaining twenty-five samples, the nine of T. J. Preston and the three of Sitley & Son, are also guaranteed 32 per cent. of protein and 5 per cent. of fat, and all but one of Sitley & Son's exceed these guarantees. The one in question is 4.44 per cent. low in protein. But one other sample is guaranteed, the guarantee in this case being 40.96 of protein and 8.65 per cent. of fat. The sample contains, however, but 37.33 per cent. of protein and 8.07 per cent. of fat, indicating that it is quite as good in quality as any, but guaranteed too high.

The remaining twelve samples were not accompanied by any guarantee, as may be seen from the table. Among them are ten with sufficient percentages to more than meet a guarantee of 32 and 5. Two samples, however, No. 1232 of Titus, Wells & Willis, and No. 1262, of unknown source, and taken from the stock of C. Pountney, of Elizabeth, are low in their content of protein, the former containing 28.74 and the latter but 23.70 per cent. The former contains 9.28 per cent. and the latter 15.06 per cent. of fiber (woody matter), whereas linseed meal, on the average, contains but 7.3 per cent. In the case of the latter sample, at least, it would seem that there has been an admixture of foreign substance. The microscope reveals a substance having the appearance of ground corn cob, though such an adulterant of linseed meal has never been brought to our attention heretofore.

The samples of *Flaxseed Meal* are not required to be guaranteed, and none were so accompanied.

Gluten Meals and Feeds.

Six samples of *Chicago Gluten Meal* are reported with varying guarantees, one claiming 36 per cent. of protein, two 38 per cent., one 39 per cent., and two 39.50 per cent. The guarantee of fat is 3.30 in two instances and 3.37 in the others. These claims are practically fulfilled, except in the case of the fat of sample No. 1040, and in the case of the protein in samples Nos. 1018 and 1485, which have the guarantees of 39.50 per cent. As an explanation of the discrepancies it may be stated that the guarantees in the case of this product are computed on the supposition of an absolutely dry material. Nevertheless the law requires that the statement on the package shall show the percentage it (the feeding stuff contained therein) contains of crude fat and of crude protein. The Station, therefore, cannot undertake to re-calculate guarantees, even if the sample's actual content of moisture were furnished, which is not the case.

The three samples of *Davenport Gluten Feed* are quite uniform in composition and uniformly low in protein. The single sample of *Waukegan Gluten Feed* is also low in protein.

Sixteen samples of *Buffalo Gluten Feed* are reported, four of which were not accompanied by guarantees. The guarantees which were furnished vary from 27 to 28 per cent. of protein, and from 2 to 3.30 of fat. The analyses show that the guarantee of fat is either exceeded or practically fulfilled in every case. In regard to the protein, however, the same can be said in the case of only two of the twelve samples.

The four samples of *Rockford Diamond Gluten Feed* and the sample of *Marshalltown Gluten Feed* exceed their guarantees in both protein and fat.

Of the seven samples of the National Starch Manufacturing Company's *Gluten Feed*, only two are guaranteed, and one of these is deficient in both protein and fat. The two guarantees are quite dissimilar and the analyses of the samples indicate two grades, according to the two guarantees, viz., about 21 per cent. and about 28 per cent. of protein.

Two other *Gluten Feeds* appear in the tables, neither accompanied by a guarantee. In the case of No. 1340, the manufacturer is unknown; in the case of No. 1255, it was reported to be the Glucose Sugar Refining Company. This company, however, so far as our knowledge goes, puts out no brand of gluten feed as low as this one

Brewery Products.

Fifteen samples of *Dried Brewers' Grains* have been examined; four were not guaranteed. Of the eleven with guarantees, five, the samples of the goods of J. C. Klauder, of Philadelphia, Pa., are found to be deficient in protein. It should be stated, however, that the guarantee of this brand of brewers' grains is placed unusually high without any corresponding increase in its price.

Twenty-three samples of *Malt Sprouts* have been examined; eight have no guarantees at all, and one has a guarantee in protein only. Of the remainder, six are low in protein, viz., two of E. P. Mueller's six samples, both of Hottelet & Company's samples, one of M. G. Rankin & Company's two samples, and the sample No. 1370 of unknown manufacture.

Wheat Feeds.

Of the seven wheat feeds examined, three, those of the American Cereal Company's *Buckeye Feeds*, were accompanied by a guarantee. These samples all supplied the nutrients practically as guaranteed. The sixteen samples of *Wheat Bran* and the two samples of *Ship Stuff* do not require guarantees, nor do the wheat feeds when consisting of the unseparated bran and middlings from the manufacture of flour.

H. O. Dairy Feed and Germ Oil Meal.

The five samples of *H. O. Dairy Feed* were all accompanied by a guarantee, which in the case of the fat was uniformly too high. In the case of the protein, however, sample No. 1320 is the only one seriously deficient. The samples of *Germ Oil Meal* of the Cerealine Manufacturing Company were not accompanied by any guarantee. In most cases the dealers in cerealine feed reported that the slabs of unground cake were found in the car with the cerealine feed.

II. CARBOHYDRATE FEEDS.

Hominy Feed.

There are fifteen manufacturers of hominy feed represented by our samples. Of these, eleven furnish guarantees with thirteen brands, which in the majority of cases correctly represent their quality. In samples Nos. 1042, 1053, 1060 and 1167, there is a deficiency in protein, and in samples Nos. 1023 and 1192, a deficiency in fat. The remaining

seven brands have no guarantee whatever. They are average brands, however, with the exception of No. 1035, which is so deficient as to render it necessary to exclude it when computing the average. Upon investigation, it was found to contain 11.86 per cent. of fiber (woody matter), whereas average hominy feed contains 3.6 per cent. of this ingredient. It was acknowledged to be of inferior grade, on account of which it was sold at $18 instead of $19 per ton. It contains seventy-three hundredths of the average amount of protein, and sixty-six hundredths of the fat at ninety-five hundredths of the price.

Mixed Feed.

The eight samples of *Quaker Dairy Feed*, and the two samples of *Corn, Oats and Barley Feed*, all agree well with their guarantees. Likewise the twelve samples of *Victor Corn and Oats*, with the exception of No. 1213, which is slightly low in its protein.

The eight samples of *H. O. Horse Feed* are correct in guarantee of protein in every instance, but in the case of the fat the guarantees are too high in every instance, all but one sample being more than a quarter of a per cent. less than is guaranteed. The guaranteed amount is 4.50 per cent., and the average amount found 3.89 per cent.

Sugar Feed.

The five samples of corn bran or sugar feed of the Glucose Sugar Refining Company are correctly guaranteed in the case of protein, except in one instance, but the guarantee of fat is higher than the content of the same, except in one instance, and practically identical in another. In the sample of John Rankin & Company, the guarantee of fat is about one per cent. too high ; in that of Wm. T. Reynolds & Company, the guarantee of protein is too high, and in that of the Chas. Pope Glucose Company, both guarantees exceed the amounts found.

In the case of the four samples of the goods of Taylor Bros. there appears to be some confusion, two only being guaranteed, showing a shortage of protein in one instance, and great variations among the four.

Cerealine Feed.

The samples of cerealine feeds show quite a variation, both in composition and guarantee. The three samples guaranteed to contain 7.88 per cent. of protein, and 5.45 per cent. of fat, contain

practically these amounts. Sample No. 1331 contains more than the guaranteed 10.82 per cent. of protein and 7.57 per cent. of fat, but the four remaining samples fall short of supplying the 13.19 per cent. of protein guaranteed in two instances, and the 14 per cent. in the other two, although they do supply the amount of fat which is claimed.

Horse Feeds.

The twenty-two horse feeds which are not made from whole grains ground together, are required by law to be accompanied by a guarantee or a statement of their component parts. This is the case in all but five instances in all of which the promises are practically fulfilled.

Stock and Dairy Feeds.

Ten samples of *Chester Stock Feed* have been analysed. Eight are guaranteed to contain 11.50 per cent. of protein and 4.20 per cent. of fat, whereas the other two are guaranteed lower. In no case does the content of protein reach within several per cent. of that guaranteed, while in but three cases is the content of fat within a quarter of a per cent. of that guaranteed.

In the case of the samples of *Friend's Concentrated Dairy Feed*, not one of the four reaches its guarantee of protein and only one of the four its guarantee of fat.

Six additional *Dairy Feeds* are reported, of which three have guarantees and three have none. Of the three which have, two are deficient in protein.

Oat Feeds.

Eleven samples of oat feeds are reported, one of which was not accompanied by a guarantee. Of the ten remaining samples, there are only four which practically satisfy their guarantees, those which do not being two of the six samples of the Vim Oat Feed, both samples of Royal Feed, and two single samples of unknown manufacture. One of the three samples of *Oat Chop* is deficient in protein, being that of A. E. Howe, as is also the sample of *Durham Corn and Oat Feed.*

The analyses of eighteen samples of miscellaneous feeds follow in the tables, of which four are accompanied by guarantees, which are found to be correct, except in the case of the protein of the *Sugar Beet Feed.* Of the remaining fourteen samples, the clover meal, hulled oats, ground

oats, corn meal, rye bran, rye middlings and the mixed feed, consisting of the accumulation of millers' tolls (pure grains ground together), are exempt. The remainder should be guaranteed.

III. FEEDS MADE FROM WHOLE GRAINS.

The feeds made from whole grains, or from materials in their natural state, are not required to be accompanied by a guarantee. They include: (1) The horse feeds, (2) corn and oats, and (3) corn ear or "cob" meal. Nevertheless, an inspection of these goods, and in fact of all feeds, is authorized by the law.

IV. POULTRY, STOCK AND CONDIMENTAL FOODS.

A few of each of these feeds have been examined. The poultry feeds are all foods simply — that is, they supply nourishment, whereas the calf meals and other foods for animals are medicinal as well.

Of the *Poultry Feeds*, the H. O. Feed is in every case substantially as guaranteed, except in the fat of two samples, and the American Poultry Food is low in protein in both of the samples. The sample of Fidelity Food for Young Chicks is likewise low in protein. Of the remaining poultry feeds, the H. O. Scratching Feed and the Wheat Screenings, being whole grains, are not required to be guaranteed. The other three are derelict in this respect.

Of the *Stock Foods*, the three samples of Blatchford's Calf Meal are all deficient in protein guaranteed, the two samples of American Calf Meal have guarantees substantially correct, and the sample, each, of Banner Stock Food and Baum's Horse and Stock Feed were accompanied by no guarantee whatever.

A few samples of ground meat scrap, etc., were collected. Upon examination, they were found either unguaranteed or with guarantees very wide from the actual content, as, for example, in the case of sample No. 1244, guaranteed to contain 30 per cent. of protein and 20 per cent. of fat, and actually containing 53.59 per cent. and 14.92 per cent., respectively, of these ingredients.

THE ACTUAL COMPOSITION.

The fact that certain feeds do or do not furnish the nutrients as guaranteed is not the only point of interest in the examination of a lot of feeds such as has here been reported. The average reader will

inquire why there should be so many feeds of such different composition, and why should guarantees be required. In answer to such questioning, it has been déemed that a brief discussion of the origin of these feeds and of their actual composition may perhaps prove interesting at least, if not helpful in their purchase and use. As stated before, the feeds which are characterized by a high percentage of protein are classified together as the protein feeds, and, similarly, those containing little protein and considerable carbohydrates are called the carbohydrate feeds. Protein is the flesh-forming constituent, and might be called the lean meat of the animal's dinner. The carbohydrates, on the other hand, are the fat-forming constituents, and consist either of fat itself or of starch, sugar, or some kindred product, which, when eaten by the animal, goes toward the production of fat or maintains the animal in weight and warmth, while performing, with the assistance of the protein, the work or other purpose for which it is kept. Scientific investigation of actual practice has disclosed the fact that the best results are obtained when, under equal conditions, certain definite proportions of protein are present in the food. This proportion is called the "nutritive ratio." To secure the proper nutritive ratio for the purpose in hand, protein feeds and carbohydrate feeds must be mixed together, and, except when more progressive practice obtains, most farm products are carbohydrate feeds.

PROTEIN FEEDS.

All seeds or grains naturally contain certain amounts of protein and carbohydrates, and either whole or ground, are fed to the animals of the farm, as when corn is fed to cattle or oats to horses. But man has found that certain portions only of the grains are pleasing to his own taste or useful in his arts and manufactures. By machinery or other manipulation, therefore, he separates the portions which he desires and leaves the remainder for his cattle.

Probably the most familiar practice of this description is the grinding of wheat. The softer starchy portions are separated as flour, and the bran and middlings are left to form protein feeds of great value in the feeding of animals. The manufacture of starch, and of glucose, which is made from starch, likewise abstracts from corn the most of its carbohydrates, leaving a residue which is ground up to form a gluten feed. In the manufacture of beer and whisky, the starch is likewise abstracted for fermentation, and the exhausted brewers' or

distillers' grains, when dried to prevent further fermentation, form another feed rich in protein.

On the other hand, the oils of seeds in many instances are of great value in the arts, and, being removed by pressure or other process, leave residues rich in protein, as, for example, the linseed meal from the manufacture of linseed oil.

These residues, it must be clearly understood, are identical, so far as they go, with the natural product from which they are formed. The protein in linseed meal is identical with that in the flaxseed; the fat or oil has merely been removed. It is just as if one should squeeze a lemon, retaining the skin in one's hand; the portion remaining in the hand would be lemon skin still, and mostly lemon skin. The protein in dried brewers' grains is the protein of the barley grain, and the protein of gluten meal is the protein of the corn kernel, just as much as the protein of wheat bran is the protein of the crushed wheat, or of the whole grain. The only difference is that it is concentrated, and hence there is more of it in a given weight, or, in other words, it is there in a higher percentage, and as the process to which each has been subjected is more or less uniformly perfect, so will the product be more or less concentrated, and more or less constant in composition. With these points in view, the origin, composition and uniformity of the different feeds will be discussed.

Cottonseed Meal.

The seed of the cotton plant is cleaned from the adhering portions of cotton fiber, and the black shell-like hull removed (*i. e.*, the seed is decorticated), after which the kernel or meat is cooked and exposed to pressure to express the oil. The residuary slabs of cottonseed cake are pulverized to form the bright yellow cottonseed meal of commerce. Several imperfections in the process may operate in producing variableness in the protein of the product, viz., an imperfect removal of the lint, or of the hulls, or of the oil. Any of these would reduce the content of protein. The last shows itself on analysis when a low content of protein is accompanied by a high content of fat; the second is apparent from the meal's darker color, except when the first also occurs, for then the yellow meal is entangled in the lint, which adheres to the hull, so as to hide the presence of the latter, except from a minute examination. The samples examined this year are mainly of good quality, thirty-one out of thirty-seven equaling or

exceeding 43 per cent. of protein, and the entire number averaging 45.71 per cent. of protein and 9.48 per cent. of fat. The range in protein is from 38.03 per cent. to 48.55 per cent., or over 10½ per cent. There are many feeds whose total content of protein is less than this variation in cottonseed. Perhaps it is impossible to secure a more uniform product than this, and as long as the actual composition exceeds the modest guarantee which has been fixed, there is no room for complaint.

Linseed Meal.

This product is similar in its origin to cottonseed meal, in that it is made by grinding the cake, which is left after pressing out the linseed oil from flaxseed, and hence it is often called "Cake Meal." This process, which is the "old process," admits of a variability due to imperfect removal of the oil. The new process of removing the fat is by extracting with naphtha, benzine, or a similar solvent of oily matter. This removes more of the fat, and hence the "new process" meal is richer in protein, and poorer in fat than the "old process" meal. The samples analysed ranged from 27.56 to 37.67 per cent. of protein, or a difference of 10.11 per cent. The average analysis of all of them is 33.30 per cent. As long as they exceed their guarantees, however, no criticism can be made. The adulteration of sample No. 1262 has already been noticed, and the sample is therefore disregarded, in considering the rariability in composition.

Flaxseed Meal.

The analyses of flaxseed meal show much greater fluctuations than would be expected in a material which had received no other treatment except grinding. Three of the samples contain so much less of both protein and fat than is usual that it was necessary to exclude them from the average.

The Gluten Products.

Gluten meal and the gluten feeds are the residues, or parts of the residues, from the manufacture of starch and glucose. This subject was studied and reported in 1894, from the report of which year much of the following is an abstract. The processes by which the starch is obtained, while perhaps differing somewhat, consist essentially in the separation, first, of the germ and hull from the starch

and gluten; and second, the final separation of the gluten from the starch, which is effected by allowing the fluid in which they are suspended to flow through long troughs, the heavier starch settling to the bottom, and the lighter yellow substance, containing the protein and fat, floating off.

The residue in this manufacture may, therefore, consist either of three products when the gluten, germs and hulls are kept separate, or of mixtures of two or of all three of these. In any case, however, the feeds are parts of the original corn, though when dried for market they differ in appearance, in proportion of food constituents, and in physical character.

The entire residue mixed together is in color a brighter yellow than corn meal, and of a much more bulky character, owing to the presence of a larger proportion of the bran; the trade name of this product is "Gluten Feed." The gluten, by itself, is distinguished by a higher content of protein and a deeper yellow color, and is called "Gluten Meal." The germ is more bulky than the meals, shows a high content of crude fat and is called "Germ Meal." The fat is sometimes extracted, when, similarly to linseed meal, the residue is called "Germ Oil Cake," and, when ground, "Germ Oil Meal." The hulls are very bulky, show a high content of crude fiber, and, either alone or with the germ, are sold as "Corn Bran" or "Sugar Feed."

The Chicago Gluten Meal appears from analysis to be the only case of the gluten being sold separate from the other portions of the residue. The samples analysed contain, on the average, 37.60 per cent. of protein and 3.91 per cent. of fat, and range from 35.43 to 38.95 per cent. of protein and from 2.50 to 6.13 per cent. of fat. The gradual increase in the protein is accompanied in a practically systematic manner by a diminution in the fat, showing that the variations are mainly due to imperfections in the separations.

The remaining gluten feeds are evidently the mixed residues of manufacture. The Davenport Gluten Feed is quite uniform and averages 24.39 per cent. of protein and 3.75 per cent of fat, the Buffalo Gluten Feed averages 26.51 per cent. of protein and 3.60 of fat, the Rockford Diamond Gluten Feed averages 27.32 per cent. of protein and 3.34 per cent. of fat, and the Marshalltown Gluten Feed (of which we have but a single sample) contains 29.20 per cent. of protein and 3.44 per cent. of fat. All these are the output of factories of the Glucose Sugar Refining Company. The Waukegan Gluten

Meal of the United States Sugar Refining Company, of Waukega
Ill., contains 26.36 per cent. of protein and 4.34 per cent of fa
while the samples of the National Starch Manufacturing Company
Gluten Feed apparently fall into two grades, containing on the ave
age, respectively, 28.61 and 22.24 per cent. of protein and 4.13 an
3.74 per cent. of fat.

Brewery Products.

The brewery products are the dried brewers' grains and the ma sprouts. In the manufacture of beer the barley is first caused t sprout, since the growth of the sprout causes a change of the starc into sugar. The sprouts are then removed, and the grain, wit its insoluble starch changed into soluble sugar, is soaked in wate which dissolves the sugar and in addition a small portion of th other ingredients. It is this sweet solution that is fermented to for beer. The sprouts and the spent grains are sold as cattle food, th latter sometimes in the wet condition, when they are liable to sou and hence are rarely used thus except in the immediate locality o the brewery. For storage or long shipment they are dried, and i this condition are found in the feed stores.

In the manufacture of whisky, also, the same process takes plac but in this case the grains are, in addition, rye, wheat or corn. The grains are sometimes added in the manufacture of ale and bee which might account in part for the variability of the different brand were it not that through other causes the samples of one brand occ sionally differ among themselves more than do the different branc themselves. These causes are imperfect drying, over-drying an scorching and delay in drying until souring has set in. The fir leaves too much moisture in the material, the second destroys a pa of the substance and imparts a burnt odor, and the third destroy substance and imparts more or less offensive odor. Properly-drie grains should have a peculiar, nutty odor, that is pleasant an appetizing.

The samples of dried brewers' grains which have been analyse this year are comparatively uniform in composition, ranging fro 21.49 to 29.24 per cent. in protein, and from 6.90 to 9.24 per cen in fat. The average is 25.57 per cent. of protein and 7.74 per cen of fat, all of which is undoubtedly of practically the same efficienc and value as if contained in the original barley or other grain fro which it came.

The malt sprouts range in composition from 22.79 to 30.23 per cent. of protein and from 1.44 to 3.70 per cent. of fat, and average 25.59 per cent. of protein and 2.59 per cent. of fat. In the case of the malt sprouts, about one-fourth of the crude protein is not in the form of albuminoids, which is considered the more valuable form of the protein compounds. It must be remembered that these young sprouts are very tender forms of vegetable growth, and are, therefore, highly digestible. The nutrients in them may be likened, therefore, to those of the young and tender pasture grasses in the spring.

The Wheat Feeds.

The wheat feeds in the tables are very similar in analysis to the wheat brans, but differ in not being separated, as completely at least, from the middlings. Wheat feeds may or may not contain an admixture of other grains or feeds. No statement to this effect has been received.

It is assumed that the wheat products are familiar to all feeders, and it need only be added that the same division and concentration takes place in them in making flour as takes place in the corn products in the glucose or starch manufacture. Thus there is about four times as much fat and about one-third more protein and considerable less starch in the whole wheat than in the manufactured flour. In the flour the starch has been concentrated, and in the by-products it has been excluded and the gluten and fat concentrated. This concentration is greater or less as the separation is more or less thorough. Thus the bran is richer in protein and fat than the flour; the middlings differ according as they contain more or less of the exterior parts of the grain or of the softer, starchy portions of the kernel; and middlings, for the same reason, vary from the coarser kinds through all the fancy grades up to what is known as Red Dog flour, which may be regarded either as a flour or as a middlings.

It will be noticed that there is a variation in the composition of the wheat products reported in the table. This may be due to various causes, among which may be mentioned the variation in the original wheat (spring, winter, western, local, etc.), and the variation in the process—the new roller process yielding a bran with a higher content of protein than the old milling process. The new process bran, therefore, is of greater effect in compounding rations, but many regard the old process bran as of superior digestibility.

CARBOHYDRATE FEEDS.

As distinguished from the protein feeds, the carbohydrate feeds are characterized by a high content of the starchy and similar elements of the grains, and consequently a lower content of crude protein. The two main sources of the carbohydrate feeds are corn and oats. Corn is itself a carbohydrate feed, but in the manufacture of starch or glucose, the carbohydrates have been removed so thoroughly that the residues contain the protein in such amounts as to carry them into the protein class. In the manufacture of hominy and cerealine, the separation of the starchy portions of the grain from the glutinous portions is not so perfect, and the resulting residue is still high in carbohydrates and relatively low in protein. On the other hand, the manufacture of oats into cereal food for man does not consist in the separation of carbohydrates from protein, but rather in a cleaning of the oats and a selection of the large, plump grains. The residues of this manufacture, consisting of the hulls and the light oats are, therefore, diminished in protein content to such an extent as to carry them into the carbohydrate class. Some manufacturers, aware of this depreciation, restore the protein by a judicious addition of other feeds, in some cases to such an extent as to carry the mixture into the protein class.

THE OATS PRODUCTS.

H. O. Dairy Feed.

This feed is undoubtedly an example of the fact just stated, since under the microscope it is revealed to consist of oats, corn, wheat and cottonseed meal. Oats contain on the average about 12 per cent. of protein, 5 per cent. of fat and 9½ per cent. of fiber. Oat hulls, on the other hand, contain as low as 3¼ per cent. of protein and 1 per cent. of fat, and as high as 29 per cent. of fiber. The inferiority of the hulls, as compared with the whole grain, may be thus seen, as well as the fact that the fiber is a characteristic of the hulls, and the presence of hulls is practically demonstrated by the presence of fiber. The light oats and hulls of an oatmeal factory probably have a composition somewhat between these extremes, possibly that of the "oat feed" of commerce. In the samples analysed, the addition of cottonseed meal and wheat bran has raised the content of protein to exceed that of oats by one-half more, and carry the mixture into the

protein class, among which materials it will be found, properly tabulated. The character of its base (light oats) is shown, however, by the percentage of crude fiber it still contains. These feeds are guaranteed to contain 18 per cent. of protein, and 4½ per cent. of fat, and actually contain (on the average) 18.42 per cent. and 3.85 per cent. respectively, with, in addition, 12.75 per cent. of fiber.

It should be stated here that there is no intention on the part of this Station to disparage any goods or class of goods, because of the presence of an excess of oat hulls. Although probably of no greater value than the coarsest grades of fodder they are a legitimate article of commerce, and, besides, are considered by many authorities as of value in adding bulk to the ration. It is when mixed feeds, which contain oat hulls, are sold without guarantee or statement of any kind, and the hulls are used to create the appearance of oats, that deception and fraud enter.

Quaker Dairy Feed.

This feed is another outlet for the light oats of an oatmeal factory, the assisting grain being wheat. The guarantees of this brand of goods are placed at 12.03 per cent. of protein and 2.50 per cent. of fat, and the average content is 13.19 per cent. and 3.22 per cent. of these nutrients respectively. The guarantee, as well as the composition, indicates the addition of less protein-bearing material, and the content of fiber is consequently not reduced to less than an average of 17.64 per cent.

Victor Corn and Oat Feed.

In this brand there is evidently a much smaller proportion of the oat products. On the other hand, there appears to be no addition of a protein feed. The guarantee is 8.23 per cent. of protein, and 3 per cent. of fat, and the average composition 8.73 per cent. of protein and 4.09 per cent. of fat. In the *Corn, Oat and Barley Feed* the addition of the barley has raised the percentages of the protein and fat.

H. O. Horse Feed.

This feed is similar to the H. O. Dairy Feed, except that linseed instead of cottonseed meal is used with corn and wheat as the materials to build up the feed. It is evidently the intention of the manufacturer to imitate the composition of oats, since the average

composition is 12.61 per cent. of protein, 3.89 per cent. of fat, and 9.63 per cent. of fiber. The content of fat falls below that intended, and also below that in oats; otherwise the attempt is quite successful.

Chester Stock Food.

In this feed there is no indication that more than a small portion consists of light oats or of anything else than oats and corn. The content of fiber (11.11 per cent.) is low for this class of goods, whereas the protein is about where it should be if normal oats were mixed with corn meal. The reduction of the fat below the fat content of either corn or oats would indicate that some light oats or other low grade product was used. The chief criticism to be made of this brand is that it fails absolutely to meet its guarantee; the actual content is 7.43 per cent. of protein and 3.36 per cent. of fat, whereas the guarantee of the most of the samples is 11.50 per cent. of protein and 4.20 per cent. of fat.

Friend's Concentrated Dairy Feed.

This brand is concentrated in fiber chiefly; its composition is not far from that of the oat feeds, and indicates that the material is mostly light oats with a little corn. This brand also fails to meet its promises of 10.70 per cent. of protein, and 3.70 per cent. of fat, since it contains on the average but 7.98 per cent. of the former and 3.39 of the latter. Its content of fiber is 22.18 per cent.

Other Feeds.

The analyses of a few other feeds appear in the tables, ranging from 7.47 to 12.48 per cent. of protein, 2.80 to 7.42 per cent. of fat and from 5.29 to 14.89 per cent of fiber. The same considerations and conclusions apply here as in the preceding cases.

Oat Feeds.

Fourteen samples of oat feed and oat chop were also analysed. These appear to be oat hulls almost exclusively, the content of fiber ranging from 21.53 to 32.41 per cent. The guarantees, also, in every case except a few of the samples of Vim Feed, are erroneous in some particular.

CORN PRODUCTS.

The corn products, as previously indicated, are the hominy meals from the manufacture of hominy, the cerealine feeds from the manufacture of cerealine and the sugar feed from the starch and glucose industry. The origin of *sugar feed* has been described in the discussion on gluten meal, with which it is allied. This product is in most cases richer in protein than the original corn, but not sufficiently so to be classed as a protein feed. It contains about the same amount of fat as corn meal, together with considerable fiber. The separation of the carbohydrates is accountable for this concentration. In the manufacture of *cerealine feed* and of *hominy meal* the separation is not as complete; for this reason the content of protein is slightly advanced and the fat more so, especially in the case of the hominy meal.

Horse Feeds.

The analyses of twenty-two samples of *horse feeds not made from whole grains* appear in tabulated form. A few of these feeds were not guaranteed, almost all of them being accompanied by at least a statement of their ingredients. The average content of protein is 10.38 per cent., of fat, 4.66 per cent., and of fiber, 5.22 per cent. These feeds are mainly the product of New Jersey mills, and for local consumption, with a comparatively small sale. The difficulty, or rather, inconvenience, in formulating guarantees for these products arises from the fact that the proportions of their ingredients and the ingredients themselves are changed as the market changes from time to time. That this necessarily leaves the consumer in the dark as to their composition is an additional reason why they should be accompanied by a statement of their component parts, if not by a regular guaranteed analysis.

In the case of the *horse feeds made from whole grains*, and hence not required to be guaranteed, the same fluctuation of ingredients is apt to occur. Frequently the collector of feeds was informed that "we are not putting in so much —— as usual, because it has gone so high." These horse feeds were, however, of very uniform quality when all is considered, ranging in protein from 7.79 to 11.42 per cent., in fat from 2.73 to 4.71 per cent., and in fiber from 2.23 to 7.92 per cent.

Corn and Oats.

The analyses of the thirty-two samples of corn and oats indicate a very good quality for the "provender" of the State. There is no indication of any but a limited use of extremely light oats, and in only a few cases does the content of protein fall below that of corn meal. Corn ear meal, or cob meal has been used in a number of instances, and in most of them the fact was stated. The possibility of changes in the proportions of corn and oats from time to time is a disadvantage in the purchase of corn and oats ground together.

Corn Ear or Cob Meal.

Eleven samples have been analysed, with quite uniform results. The protein ranges from 6.87 to 9.39 per cent., the fat from 2.52 to 4.26 per cent., and the fiber from 3.94 to 8.20 per cent.

POULTRY STOCK AND CONDIMENTAL FOODS.

A few samples only of feeds of this character have been collected by this Station. In regard to the *Poultry Feeds*, there is no indication that they consist of anything else but a mixture of the usual materials known to be of value in the feeding of poultry. They all contain grains of recognized value. A little charcoal has been added to the H. O. Scratching Feed, some meat is apparently contained in Hopkins and Lippincott's Poultry Feed, and meat, charcoal and limestone seem to be associated with the grains which compose Fidelity Food for Young Chicks. Unless these additions are taken into account, there is no apparent reason why any of these mixtures should command a price so much higher than that for which practically the same ingredients may be bought in the ordinary cattle mixtures, not to mention their purchase in the form of grain separately. It clearly is possible for any poultry farmer to purchase charcoal, lime, meat scrap, etc., to mix with wheat screenings or other food to form a good poultry ration. These ingredients are to be found in the feed stores, especially in the districts where much poultry raising obtains. Nevertheless, for the *average* farmer it is a great convenience to be able to purchase a poultry ration ready made, for thereby he avoids the selection and storing and subsequent assembling of a lot of materials of limited use in the small quantities he would need to buy. This convenience, perhaps, offsets the increased cost.

In the case of the *Stock Foods*, the same considerations in regard to the price apply to a large degree, for in many cases the increased price seems occasioned by the addition of small quantities of material which are foreign to feeds. To be sure, they are understood to be of a medicinal or stimulating nature, and are claimed to be particularly effective and valuable, not only for growing animals, but also for cows in milk and for horses. The Station believes that healthy animals need no medicine or stimulant; stock-raisers and dairymen should know sufficiently of the common ailments of their animals to prescribe intelligently the more common and *known* remedies, and for sickness of a serious character a skillful veterinarian should be called in.

The small package in which most of these foods are put up is responsible, in large part, for the enhancement of the selling price reported in the tables, since ton prices have been calculated from package prices; but, even so, when a mixture is sold at the rate of $200 per ton it is evident that the inventor is being well paid for devising it, as well as the manufacturer for mixing it. It is fortunate that in most of these expensive preparations the directions call for the use of very small quantities.

SELLING PRICES.

The dealers' selling prices for the different materials, of which samples have been taken, were either noted at the time or secured later by correspondence. These have been entered in the tables not so much for the information of consumers as that the average prices might be computed for the period during which samples were collected. The individual prices cannot fairly be compared with each other, for the samples were gathered during a fluctuating market, but as samples of all kinds were constantly being taken whenever found, it is believed that a comparison of averages is permissible, and the average prices, therefore, have been included in the table of averages, which appears earlier in this bulletin.

An inspection of the prices of the individual samples shows that notwithstanding the fluctuations in the price of feeding stuffs, the price of *cottonseed meal* was never very far from the average, $28.70. *Linseed meal,* apparently, is quite the contrary in this respect, but the greater part of the abnormally high prices per ton are calculated from the dealers' prices for very small lots—as small in some instances as the pound. Linseed meal, under these circumstances,

is used for probably no other purpose than stuffing horses' feet, etc. Omitting such cases from consideration, the price of linseed meal was not far from the average at any time, *i. e.*, $34.08. For reasons similar to those applying to linseed meal, the prices of flaxseed meal have not been averaged.

The *glutens* have been extremely uniform in price, the higher gluten (Chicago), with an average content of 37.60 per cent. of protein, selling at the higher average price ($26.08).

The remaining feeds in the tables, furnishing protein in percentages ranging from 29.20 in Marshalltown Gluten Feed to considerably under 10.00 in certain mixed feeds, deviate very little from a uniform price of $20 per ton. An inspection of the table of averages in an earlier portion of this section will reveal the fact, if such may be termed a revelation, that quality and price by no means go hand in hand. This is the case if we consider the content of protein as the guide to quality, or if we inspect the table with an eye to the general analysis.

It is very much to be regretted that the present state of our knowledge does not admit of the placing of a valuation in dollars and cents upon the various feeds contained in the tables. Such a procedure would yield results of great practical utility to feeders and of considerable general interest as well. This is possible and is the practice with commercial fertilizers, but is impracticable with feeds. Artificial fertilizers are mixtures of raw materials, of which each supplies (as a rule) but one of the essential forms of plant food. From the price of the raw material the cost of its particular valuable ingredient can readily be determined, and this value is applicable to that ingredient wherever found. On the other hand, feeds are not artificial. In their simplest and natural forms they are nature's mixtures of water, mineral matter, protein, fat, fiber and carbohydrates. They are naturally complex materials, and the situation is further complicated by the fact that their component parts—the protein, fat, etc., in the various feeds—are in varying proportions and of varying digestibility.

The Selection of Feeds.

Not having an estimated comparitive valuation upon which to base a choice of feeds, it becomes necessary for the feeder to use a wise discrimination, based on a sufficient knowledge of feeds in general and animals in particular, to which must be added a good business sense.

The feeder should know the character of the feeds the purchase of which is under consideration. If he is well informed, the trade name will indicate its composition in a general way. If the feeds are subject to the provisions of the law, the furnished guaranteed analysis will inform him which of them are claimed to be rich in protein and which are largely carbohydrates, and the publication of the analyses of the feeds by the Experiment Station will show to what extent these claims are substantiated.

From his knowledge of feeding stuffs, also, he should know, at least approximately, the analysis of the materials which he has on hand. Home-grown fodders and feeding stuffs, which form the foundation upon which the farmer builds his ration, usually furnish all the carbohydrates and fat, but rarely all the protein needed. From an account of stock on hand he should determine his needs; if for protein, buy accordingly, for further accumulation of carbohydrates is unnecessary and wasteful.

After this is determined there comes the selection of the feed which carries the needed nutrient. All feeds are not equally digestible. Gluten meal is more digestible than either linseed or cottonseed; rye meal and barley are more digestible than wheat bran or middlings. And yet the linseed, cottonseed, wheat bran and middlings should not be dropped from use. There is a greater adaptability of certain feeds to the needs of particular animals. Poultry and swine do not relish or do well on cottonseed meal. The feed must be selected so that the ration may be palatable. When animals do not like their food they do not do well. A variety of materials must be furnished, and the fodders and feeds must be so combined as to use them up during the season and still avoid the exclusive use of one or two kinds for any extended period of time.

Nevertheless, the feeder must use his business sense. When oats and corn are both hovering around $24 per ton there is no combination of pure grains that can be made which will yield the manufacturer a profit at $18 per ton. If protein feeds are desired, consider content of protein and price per ton together in the selection. The protein feeds are submitted in a wide variety, and, this year at least, the differences seem to be in analysis rather than in price.

When home-grown feed commands a high price, sell and buy cheaper feeds. In many instances the purse and the ration are both improved. If corn is high and, therefore, to be sold, and gluten meal is bought in its place, the best of the corn is brought home again. It is a common practice to exchange wheat for wheat bran;

why not corn for gluten meal or feed? Still, this is not applicable to all feeds; for while an exchange of corn for gluten products returns the best of the corn, the exchange of oats for oat feed returns the poorest portions of the oats.

On the other hand, the home-grown products may be cheap, and there is a point when the exchange, though desirable from the standpoint of the ration, will not prove profitable enough to warrant itself. Remoteness from market, the price of feeds, the freight rates and the small returns from dairy products may so change conditions as to render one feeder's folly, in feeding carbohydrates wastefully, the most profitable, if not the most desirable, course for another feeder to pursue.

All these things must be borne in mind by the feeder who would be successful. When buying, buy wisely. Buy either standard goods, the quality of which may be judged pretty accurately, or insist on guarantees. Avoid the materials which are marked down because they are slightly below grade. Usually the reduction in price is by no means large enough, and having accepted the goods with the statement that they are damaged or deficient, there is no redress.

Of course it must be remembered that certain products are exempted from the provisions of the law, as stated in the opening pages of this section. As to the others, the Station expects to do its duty in the matter. In the fertilizer inspection it has been found that the desire to stand well in the published results of the inspection has been an important factor in causing a careful attention to legal provisions. At the same time, those who find it necessary to purchase feeding stuffs should remember that they can largely assist in determining the extent to which the law is obeyed. If they refuse to buy goods not properly marked or for which no guaranteed analysis can be furnished, when under the law such should be furnished, dealers will not handle such goods; and when dealers refuse to handle a particular brand, the manufacturer will be obliged to comply with the law to protect his interests.

III.

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Since the establishment of this Station in 1880, a large number of analyses of fodders and feeds have been made in its laboratory. The results of these analyses, showing the composition of the different samples and variations in the composition of materials of the same kind, have appeared from year to year in the reports of this Station, accompanied by such comments and explanations as were deemed necessary.

The following tables of analyses have been compiled for convenience of use and as a guide to the composition of the fodders grown in this State, and the feeds for sale in its markets. The tables include 1,251 analyses, representing 176 different kinds of fodders and feeds. Differences in composition are observed between those fodders grown upon soils in a good state of fertility and rich in organic matter, and those grown on light and sandy soils ; in nearly every case the former are richer in fat and protein. Great differences are likely to occur, also, if hay, corn fodder, straw, etc., are not cut at the proper time, or not gathered in good condition. The feeds, on the other hand, when properly classified, are reasonably uniform in composition. While these averages are therefore trustworthy in the majority of cases, judgment must be exercised when products used are known to be either extra good or very poor.

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Number of Analyses.		POUNDS PER HUNDRED.								
		Water.	Ether Extract.	Fiber.	Protein.	Ash.	Nitrogen—Free Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	GREEN FODDER.									
	Cereal Grasses.									
28	Corn (Maize)	74.8	0.5	5.8	1.7	1.6	15.6	0.28	0.18	0.33
1	Leaming Corn	76.4	0.6	4.9	1.9	1.0	15.2	0.30	0.18	0.32
1	Red Kaffir Corn	81.6	0.6	4.8	1.8	1.8	9.9	0.29	0.18	0.45
1	White Kaffir Corn	83.4	0.7	4.6	1.9	1.4	8.0	0.30	0.12	0.50
1	White Thoroughbred Corn	80.3	0.6	3.8	1.7	0.9	12.7	0 26	0.12	0.28
1	Southern White Corn	78.5	1.0	5.3	1.5	1.0	17.7	0.24	0.10	0.24
1	Evergreen Broom Corn	77.1	0·5	8.6	2.0	1.7	10.1	0.32	0.17	0.70
1	Stowel Evergreen Corn	77.9	0.6	4.5	1.8	1.2	14.0	0.28	0.14	0.38
1	Teosinte	90.1	0.3	2.7	1.4	1.4	4.1	0.23	0.05	0.66
1	Rural Branching Doura	85.9	0.4	4.7	1.7	1.3	6.0	0.28	0.15	0.46
1	Yellow Millo Maize	83.2	0.6	5.5	1.7	1.5	7.5	0.27	0.11	0.57
9	Rye	77.0	0.6	10.1	2.3	1.9	8.1	0.37	0.24	0.64
8	Sorghum	72.6	0.3	6.2	0.8	1.0	19.1	0.13	0.(5	0.19
2	Sugar Cane	84.2	0.5	4.0	1.2	1.1	9.0	0.20	0.09	0.44
2	Japan Millet	79.8	0.6	5.7	2.0	1.9	10.0	0.32	0.16	0.65
1	Japan Broom Corn Millet	77.4	0.9	6.2	4.0	2.4	9.1	0.64	0.16	0.73
3	Barnyard Millet	82.7	0.6	4.9	1.5	1.5	8.8	0.23	0.11	0.49
1	Pearl Millet	83.0	0.4	5.5	1.1	1.7	8.3	0.18	0.15	0.71
1	Barley	81.7	0.9	4.2	2.9	1.7	8.6	0.46	0.10	0.54
7	Pasture Grass	63.1	1.5	7.4	5.6	3.2	19.2	0.90	0.26	0.74
1	Wheat	77.3	0.7	5.9	2.4	1.8	11.9	0.38	0.16	0.60
	Legumes.									
3	Red Clover	71.9	0.8	8.4	3.0	3.5	12.4	0.48	0.12	0.83
12	Crimson Clover	84.0	0.5	4.1	3.0	1.4	7.0	0.47	0.12	0.39
29	Alfalfa	75.0	0.9	6.5	4.5	2.2	10.9	0.72	0.14	0.70
11	Cow Pea	82.5	0.7	3.8	3.1	1.7	8.2	0.50	0.14	0.46
8	Canada Field Pea	81.7	0.6	4.8	2.4	1.6	8.9	0.38	0.17	0.46
8	Soy Bean	79.8	0.8	5.3	3.0	2.0	9.1	0.48	0.15	0.49
1	Velvet Bean	82.2	0.7	5.1	3.5	1.9	6.6	0.55	0.14	0.57
1	Sand Vetch	88.1	0.5	2.6	3.5	1.5	3.8	0.56	0.15	0.54
2	Dwarf Essex Rape	87.9	0.5	1.2	2.4	1.6	6.4	0.37	0.13	0.47
	SILAGE.									
22	Corn (Maize) Silage	79.8	0.7	5.8	1.5	1.3	10.9	0.24	0.12	0.33
6	Sorghum Silage	75.8	0.3	6.3	0.8	1.0	15.8	0.13	0.15	0.19
1	Red Clover Silage	72.6	0.9	8.6	3.8	2.7	11.4	0.61	....	....
4	Brewers' Grains Silage	70.3	2.1	4.5	6.3	1.2	15.6	1.01	....	....
1	Rye Silage	80.8	0.3	5.8	2.4	1.6	9.1	0.38	....	....

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Number of Analyses.		POUNDS PER HUNDRED.								
		Water.	Ether Extract.	Fiber.	Protein.	Ash.	Nitrogen—Free Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	HAY AND DRIED COARSE FODDER.									
11	Corn Fodder, Field-Cured	25.0	1.7	20.3	5.5	4.9	42.6	0.88	0.36	1.06
16	Cornstalks, Dried	14.7	1.2	27.3	5.1	5.5	46.2	0.82	0.28	0.95
2	Cornstalks, Field-Cured	37.7	1.5	18.9	3.8	3.4	34.7	0.61	0.33	0.33
	Hays from Grasses Named.									
3	Orchard Grass	6.9	1.8	32.3	5.7	5.2	48.1	0.91	0.28	1.64
15	Timothy	11.2	1.9	28.5	6.0	4.2	48.2	0.96	0.36	1.26
8	Hungarian Grass	7.4	1.8	28.0	7.3	6.1	49.4	1.16	0.35	1.29
1	Short Sedge	8.5	2.4	21.3	7.3	10.6	49.9	1.16	0.14	1.18
2	Creek Sedge, Field-Cured	41.8	1.1	16.2	2.0	6.6	32.3	0.33	0.08	0.58
1	Herd Grass	7.5	1.5	26.6	6.3	4.8	53.3	1.00	0.35	1.57
3	Salt Marsh Hay	8.1	2.0	25.8	4.5	6.1	53.5	0.73	0.09	0.82
4	Black Grass	9.3	2.5	25.7	6.7	6.9	48.9	1.07	....	....
1	Marsh Rosemary	7.8	2.0	25.1	5.3	5.8	54.0	0.84	0.06	0.27
2	Bog Hay	8.1	2.2	25.1	7.7	8.3	48.6	1.23	0.18	0.78
	Hays from Legumes Named.									
12	Red Clover	8.2	2.3	28.3	12.3	6.6	42.3	1.97	0.40	1.75
1	Alsike Clover	7.5	1.6	29.5	11.4	6.4	43.6	1.83	0.39	2.15
1	White Clover	7.1	2.1	27.3	14.1	9.0	40.4	2.25	0.25	1.06
2	Crimson Clover	8.0	1.7	32.0	15.6	8.4	34.3	2.49	0.66	2.28
5	Alfalfa	9.5	2.6	29.2	15.6	7.5	35.6	2.51	0.48	2.47
3	Cow Pea	12.5	2.1	20.0	16.0	8.4	41.0	2.56	0.58	1.88
1	Oats and Peas Hay	6.6	2.6	30.7	8.0	6.5	45.6	1.28	0.63	1.46
1	Oats and Peas Straw	9.2	2.3	32.8	4.1	6.9	44.7	0.66	0.38	3.20
15	Wheat Straw	7.5	1.6	37.9	2.7	3.7	46.6	0.43	0.13	0.74
6	Rye Straw	6.6	1.3	38.2	3.1	3.3	47.5	0.50	0.29	0.79
7	Oat Straw	8.1	2.1	36.3	4.0	4.8	44.7	0.65	0.22	1.22
1	Buckwheat Straw	9.0	0.7	37.2	7.8	6.5	38.8	1.24	0.18	1.14
1	Sorghum Leaves	10.4	2.0	23.7	9.6	5.4	48.9	1.54	0.52	1.12
1	Sweet Potato Vines, Yellow	13.1	1.7	11.9	15.4	11.8	46.1	2.46	0.60	1.69
1	Sweet Potato Vines, Red	17.2	1.2	14.8	10.6	8.9	47.3	1.69	0.44	1.44
	ROOTS, TUBERS, AND VEGETABLES.									
41	Potatoes	79.1	0.1	0.4	2.1	0.9	17.4	0.33	0.12	0.44
15	Sweet Potatoes	72.6	0.3	0.7	1.0	1.4	24.0	0.16	0.10	0.49
4	Sugar Beets	82.0	0.1	1.1	1.6	1.2	14.0	0.26	0.12	0.48
1	Mangelwurzels	91.8	0.1	0.7	1.2	0.9	5.3	0.19	0.06	0.46
12	Tomatoes	94.0	0.4	0.5	0.8	0.5	3.8	0.13	0.07	0.25
1	Apples	84.8	0.3	1.2	0.6	0.3	12.8	0.10	0.02	0.14

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Number of Analyses.		POUNDS PER HUNDRED.								
		Water.	Ether Extract.	Fiber.	Protein.	Ash.	Nitrogen—Free Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	GRAINS AND OTHER SEEDS									
15	Corn (Maize) Kernel	15.4	4.1	1.5	9.1	1.8	68.6	1.48	0.61	0.36
6	Sorghum Seed	12.8	8.6	1.8	8.6	1.8	71.9	1.88	....	....
20	Oats	11.4	4.8	9.9	11.8	8.1	59.5	1.81	0.77	0.57
6	Rye	12.0	1.7	1.7	10.2	1.8	72.6	1.62	0.81	0.52
21	Wheat	12.7	1.7	1.9	10.8	1.9	71.0	1.78	0.96	0.35
1	Buckwheat	10.8	2.5	8.7	10.1	2.8	65.6	1.62	0.78	0.59
1	Soy Bean	9.6	19.0	5.0	85.4	4.8	26.2	5.67	....	....
2	Cow Pea	10.9	1.5	3.4	19.5	8.8	61.4	8.12	1.01	1.30
1	Blackeyed Pea	12.2	1.6	4.1	21.6	8.8	57.2	8.46	....	....
1	Hungarian Grass Seed	9.5	4.7	7.7	9.9	5.0	68.2	1.59	0.47	0.38
1	Broom-corn Seed	8.9	2.6	....	10.7	4.5	*78.8	1.71	0.72	0.52
1	Rice	12.0	0.8	0.1	7.4	0.2	80.0	1.18	....	....
1	Oats and Peas	9.9	8.8	10.9	16.7	4.7	54.0	2.68	1.02	0.92
	MILL PRODUCTS.									
41	Corn (Maize) Meal	12.9	4.0	1.8	9.1	1.5	70.7	1.47	0.62	0.38
13	Cob Meal	12.5	8.4	5.9	7.6	1.4	69.2	1.22	0.55	0.46
4	Ground Oats	10.8	5.1	9.8	11.2	8.8	59.8	1.79	0.76	0.50
38	Ground Corn and Oats	11.9	4.5	4.0	9.7	2.2	67.7	1.55	0.71	0.44
6	Wheat Flour	12.4	1.2	....	12.0	0.4	74.0	1.92	....	....
5	Buckwheat Flour	14.1	0.8	....	4.8	0.7	79.6	0.77	0.52	0.16
1	Rice Meal	8.5	14.1	8.0	14.4	7.4	47.6	2.30	....	....
2	Pea Meal	10.8	2.2	....	27.4	2.5	*57.1	4.39	0.91	0.99
1	Bean Meal	10.9	1.5	3.8	28.2	5.7	54.9	3.72	0.94	1.45
7	Flaxseed Meal	8.0	35.6	4.9	24.5	4.0	28.0	8.92	1.30	0.98
	BY-PRODUCTS AND WASTE MATERIALS.									
4	Corn (Maize) Cob	31.5	0.8	24.0	1.5	1.0	41.7	0.24	0.07	0.29
29	Hominy Chop, or Meal	9.5	8.8	8.5	10.8	2.8	64.6	1.72	1.48	0.75
15	Chicago Gluten Meal	9.8	4.6	1.9	35.9	0.9	46.9	5.74	0.34	0.06
1	Cream Gluten Meal	7.4	15.6	1.5	41.8	1.6	32.1	6.68	0.81	0.06
3	Hammond Gluten Meal	8.2	11.1	0.9	28.4	1.0	50.4	4.54	0.50	0.08
2	King Gluten Meal	8.8	18.5	1.4	37.2	1.4	33.2	5.95	0.66	0.06
11	† Buffalo Gluten Feed	8.2	12.8	6.6	22.0	0.9	49.5	3.52	0.39	0.06
19	Buffalo Gluten Feed	8.7	8.5	6.9	26.7	8.0	51.2	4.27	....	....
2	Iowa Golden Gluten Feed	8.8	11.6	8.1	29.4	1.0	46.6	4.70	0.48	0.08
2	† Rockford Diamond Gluten Feed	9.0	4.2	8.0	22.9	1.0	54.9	3.66	....	....
4	Rockford Diamond Gluten Feed	....	8.8	....	27.8	....	....	4.37	....	....
1	Atlas Gluten Feed	7.5	9.8	10.6	20.8	1.8	50.0	3.31	0.60	0.28

* Includes fiber. † Samples prior to 1897.

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Number of Analyses.		Water.	Ether Extract.	Fiber.	Protein.	Ash.	Nitrogen—Free Extract.	Nitrogen.	Phosphoric Acid.	Potash.
		POUNDS PER HUNDRED.								
	BY-PRODUCTS AND WASTE MATERIALS—(Con).									
4	Davenport Gluten Feed	7.8	4.4	7.5	24.1	1.2	55.0	3.86	....	....
1	Waukegan Gluten Feed	....	4.8	....	26.4	....	....	4.22	....	....
1	Marshalltown Gluten Feed	....	3.4	....	29.2	....	....	4.67	....	....
3	Grano Gluten Feed	6.0	14.2	11.4	31.0	2.7	34.7	4.96	0.66	0.20
10	Cerealine Feed	9.8	7.1	5.6	9.8	2.6	65.1	1.57	1.27	0.67
2	Corn Germ Meal	7.2	10.8	7.8	11.4	1.6	61.2	1.82	0.89	0.21
3	Corn Oil Meal	9.0	13.5	6.7	24.8	2.4	43.6	3.97	1.40	0.18
4	Germ Oil Meal	....	9.7	....	16.3	....	....	2.61	....	....
1	Corn Sprouts	8.3	2.3	5.8	26.0	5.6	52.0	4.16	1.51	1.84
18	Corn Bran, or Hulls	8.4	5.8	11.8	9.7	1.3	63.0	1.55	0.62	0.40
5	Fancy Corn Bran	....	3.4	12.0	13.4	....	....	2.14	....	....
1	Maizeline	....	9.0	6.8	10.4	....	....	1.66	....	....
4	Starch Feed, Wet	68.8	3.0	2.9	5.0	0.4	19.9	0.80	0.05	0.02
2	Starch Feed, Dried	9.1	3.8	6.7	14.6	0.9	64.0	2.34	....	....
6	Vim Oat Feed	....	2.2	28.1	5.6	....	....	0.90	....	....
3	Royal Oat Feed	7.7	3.4	22.7	7.3	....	....	1.17	....	....
4	Oat Chop	6.8	3.1	22.1	8.3	5.9	53.8	1.34	0.66	0.69
6	Oat Hulls	7.3	1.1	31.6	2.9	6.7	50.4	0.46	0.24	0.52
1	Hulled Oats	....	7.6	....	16.2	....	....	2.59	....	....
1	De Fi Corn and Oat Feed	....	3.1	14.9	8.7	....	....	1.39	....	....
1	Durham Corn and Oat Feed	....	2.8	13.1	7.5	....	....	1.20	....	....
12	Victor Corn and Oat Feed	....	4.1	10.8	8.7	....	....	1.39	....	....
2	Corn, Oat and Barley Feed	....	4.6	11.5	11.4	....	....	1.82	....	....
9	Quaker Dairy Feed	6.8	3.3	17.6	13.0	5.4	53.9	2.08	....	....
9	H. O. Dairy Feed	3.3	4.2	12.3	18.5	3.6	58.1	2.96	0.84	0.60
9	H. O. Horse Feed	9.6	3.9	9.8	12.6	2.6	61.5	2.02	....	....
5	Friends' Dairy Feed	4.9	3.5	21.5	8.0	5.7	56.4	1.28	0.68	0.65
10	Chester Stock Food	....	3.4	11.1	7.4	....	....	1.18	....	....
28	Malt Sprouts	9.4	2.5	10.0	25.5	7.9	44.7	4.01	1.58	1.87
18	Brewers' Grains, Wet	74.1	2.1	3.7	6.4	1.0	12.7	1.02	0.26	0.08
42	Brewers' Grains, Dried	8.9	7.0	13.2	23.9	3.7	43.3	3.82	1.01	0.09
1	Brewers' Swill	94.3	0.8	0.7	1.9	0.3	2.0	0.30	....	....
2	Distillery Grains, Dried	7.2	15.9	13.7	26.2	1.1	35.9	4.19	0.87	0.12
78	Cottonseed Meal	7.6	10.3	5.2	44.8	6.5	25.6	7.17	3.15	1.79
9	Cotton-seed Meal, Undecorticated	8.8	7.4	18.5	25.3	4.9	35.1	4.04	1.85	1.48
1	Cotton-seed Feed	9.7	3.3	35.7	10.7	3.7	36.9	1.72	0.62	1.21

AVERAGE ANALYSES OF FODDERS AND FEEDS.

Number of Analyses.		Pounds per Hundred.								
		Water.	Ether Extract.	Fiber.	Protein.	Ash.	Nitrogen—Free Extract.	Nitrogen.	Phosphoric Acid.	Potash.
	BY-PRODUCTS AND WASTE MATERIALS—(Con).									
116	Linseed Meal, Old Process	9.7	7.8	7.8	33.8	5.5	36.4	5.41	1.94	1.3
6	Linseed Meal, New Process	9.8	3.2	8.1	35.8	5.7	38.4	5.65	2.16	1.4
2	Palm-nut Meal	8.5	12.6	22.8	14.8	3.6	37.7	2.87	....	....
1	Pea Feed	10.1	1.2	....	14.9	3.0	*70.8	2.39	0.72	0.7
1	Peanut Meal and Hulls	10.9	2.4	62 9	7.0	2.1	14.7	1.18	0.15	0.6
1	Cocoa Shells	2.7	16.5	9.9	15.5	10.7	44.7	2.48	1.14	2.3
1	Sugar Beet Feed	....	0.8	19.2	8.2	....	....	1.31	....	....
1	Clover Meal	....	3.8	29.2	5.8	....	....	0.93	....	....
8	Rice, Bran or Feed	9.0	9.3	13.0	11.5	9.2	48.0	1.84	....	....
1	Rice Polish	9.5	11.2	8.8	14.8	6.8	55.4	2.29	3.29	1.1
3	Buckwheat Bran	12.9	5.9	13.8	22.2	4.3	41.4	3.55	1.79	1.1
8	Buckwheat Middlings	18.7	5.7	2.9	21.0	3.9	52.8	3.36	1.78	1.0
9	Rye Bran	11.7	2.8	3.5	13.9	3.3	64.8	2.25	1.54	0.9
4	Rye Feed	12.1	1.8	1.4	9.3	1.7	73.7	1.49	0.77	0.4
1	Rye Middlings	12.2	2.8	1.8	13.8	1.7	68.7	2.18	0.56	0.4
1	Barley Meal	....	4.6	12.8	13.8	....	....	2.21	....	....
62	Wheat Bran	11.8	4.1	7.9	15.7	6.0	55.0	2 51	2.92	1.5
28	Wheat Middlings, White	11.4	3.6	4.2	15.4	2 7	62.7	2.46	1.35	0.7
6	Wheat Middlings, Brown	10.7	4.5	4.5	16.9	3.8	59.6	2.71	1.87	0.9
2	Wheat Shorts	11.2	3.8	2.8	15.5	2.2	65.0	2.48	1.18	0.8
2	Wheat Chaff	11.1	1.4	29.2	4.3	6.5	47.5	0.69	0.95	0.5
4	Ship Stuff	12 0	3.6	4.6	16.1	4.3	59.4	2.[illegible]8	2.04	0.5
8	Buckeye Wheat Feed	....	4.5	5.9	17.1	....	....	2.74	....	....
4	Wheat Feeds	....	4.5	7.2	17.3	....	....	2.77	....	....
2	Sucrene Dairy Feed	10.2	5.3	9.0	19.4	....	....	3.10	....	....
1	Nutrisotone	8.1	6.5	6.1	21.3	19.7	38.3	3.41	3.19	3.0
1	Paine's Stock Food	11.3	10.3	10.1	11.8	10.1	46.9	1.80	1.98	0.8
1	Banner Stock Food	....	8.4	....	22.8	....	....	3.65	....	....
1	Baum's Horse and Stock Feed	....	9.2	18.8	24.8	....	....	3.97	....	....
4	Blatchford's Calf Meal	8.7	5.3	4.7	25.3	5.7	50.8	4.05	....	....
2	American Calf Meal	....	8.0	2.8	17.4	....	....	2.78	....	....
2	American Poultry Food	....	6.6	4.7	13.0	....	....	2 08	....	....
7	H. O. Poultry Feed	....	5.5	4.7	17.4	....	....	2.78	....	....
2	H. O. Scratching Feed	....	4.4	....	12.3	....	....	1.97	....	....
3	Animal Meal	....	8.8	....	42.1	....	....	6.74	....	....
3	Beef Meal	....	12.9	....	58.8	....	....	9.41	....	....

* Includes fiber.

MARKET PRICES OF COMMERCIAL FEEDS.

The gathering of statistics concerning the average market prices of commercial feeds used in the State was begun in 1891. It has been continued since, though with some changes as to method. Up to January 1st, 1900, the records represented the average price per ton for the six months preceding January 1st. This year a change has been made, which it is believed will more accurately represent the actual prices paid for feeds during the year, since they are the average prices of feeds obtained direct from dealers, which were sampled for analysis under the law passed in 1900 and now in force. Besides, the average now represents a larger number of samples distributed more generally over the State. The results of the inspection showed a larger number of specific brands than have been included in previous years. Hence a comparative study of composition and prices cannot be made in all cases this year. Such comparisons as can be made, show that, with one exception, there has been an increase in the average price of all the feeds, ranging from 28 cents per ton for rye bran to $5.14 per ton for linseed meal. The average increase for all is 12 per cent. It is also shown that the increase affects in practically the same degree the two general classes of feeds, namely, the protein and the carbohydrate. The very considerable increase in price of corn meal, namely, 27 per cent., is suggestive, since it is one of the feeds which has been used more generally than any other by the farmer, and suggests the importance of a careful study of the exchange of home-grown products for those richer in protein.

KIND OF FEED.	AVERAGE FOR THE SIX MONTHS PRECEDING JANUARY 1.					Average from November 1, 1900, to May 15, 1901.
	1895–96.	1896–97.	1897–98.	1898–99.	1899–00.	
Cottonseed Meal	$21 86	$22 40	$23 00	$20 22	$25 33	$26 70
Linseed Meal, old process	22 65	22 97	24 82	25 80	28 94	34 06
Chicago Gluten Meal	18 66	14 88	16 88	19 88	22 42	26 08
Marshalltown Gluten Feed	......	......	......	......	......	22 00
Rockford Diamond Gluten Feed	......	......	......	15 75	17 00	21 10
Buffalo Gluten Feed	16 88	12 00	15 22	15 92	18 41	21 87
Waukegan Gluten Feed	......	......	......	......	......	21 50
Davenport Gluten Feed	......	......	......	......	......	20 70
Malt Sprouts	15 18	10 90	12 08	14 58	15 80	17 50
Dried Brewers Grains	15 88	12 88	15 18	14 92	17 67	19 06
Sucrene Dairy Feed	......	......	......	......	......	21 00
Germ Oil Meal	......	......	......	......	......	22 75
Wheat Bran	16 45	12 81	14 10	15 48	17 48	21 13
Wheat Middlings	19 67	14 98	15 85	17 87	19 15	22 63
Ship Stuff	16 88	12 75	14 89	16 67	18 22	18 50
Wheat Feed (Mill Feed)	......	......	......	......	......	19 75
Buckeye Wheat Feed	......	......	......	......	......	20 88
H. O. Dairy Feed	......	......	......	......	......	22 70
H. O. Horse Feed	......	......	......	......	......	21 88
Quaker Dairy Feed	......	......	......	......	......	18 86
Victor Corn and Oat Feed	......	......	......	......	......	18 55
Corn, Oat and Barley Feed	......	......	......	......	......	20 00
Corn Bran, or Sugar Feed	......	......	......	......	......	17 10
Barley Meal	......	......	......	......	......	22 00
Hominy Meal	16 75	12 75	18 94	15 94	17 00	19 05
Rice Feed	......	......	......	......	......	18 50
Cerealine Feed	......	......	......	......	......	19 75
Corn Meal	18 84	14 88	15 02	16 62	17 25	22 00
Ground Oats	20 92	18 76	22 58	24 81	23 75	25 00
Corn and Oats (Provender)	19 49	14 29	16 69	19 79	19 81	20 90
Corn-Ear Meal	15 95	12 60	18 67	15 92	14 88	15 41
Rye Bran	17 67	11 18	12 44	14 69	17 22	17 50
Rye Middlings	18 88	14 40	15 50	16 97	18 60	18 00
Friends' Dairy Feed	......	......	......	......	......	16 13
Chester Stock Feed	......	......	......	......	......	18 75
Oat Feed, or Chop	......	......	......	18 25	14 89	15 76

NITROGEN INVESTIGATIONS.

THE AVAILABILITY OF ORGANIC NITROGEN IN RAW MATERIALS.

BY JOHN PHILLIPS STREET.

In the report of this Station for 1898* there was suggested a method for the determination of the relative availability of the organic nitrogen in raw materials. The figures there published showed that with the materials examined, twenty in number, the method gave very satisfactory results. It was not claimed that the percentages obtained showed *absolute* availability, but it was asserted that by this method it was possible to determine the *relative* availability to the plant of the organic nitrogen obtained in the well-known ammoniates. This assertion has been confirmed in some cases by a comparison with actual vegetation tests, and in others, as, for instance, leather and the various bones, by the knowledge we possess as to what they will do in the field.

It was thought that it might be valuable likewise to ascertain the variations that occur in the availability of materials of the same class, and accordingly all of the samples of raw materials received at this Station during the past three years have been submitted to this test. In addition to these samples, the analyses published in 1898, certain samples received from referees of the Association of Official Agricultural Chemists, and various samples of the different kinds of bone from our own stock have been included. The tests reported on the following pages include the examination of 122 samples representing thirty-one different kinds of ammoniates.

For convenience, the method used is again reported :

Method.—Weigh an amount of the material equivalent to 0.075 grams of nitrogen into a 500 cc. Erlenmeyer flask ; add 100 cc. of neutral 1.6 per cent. permanganate of potash solution, and digest on a steam bath for thirty minutes, shaking occasionally to moisten any particles adhering to the sides of the flask. Filter and wash three or four times, using from 125 to 150 cc. of water. Determine the total nitrogen in the undigested residue by the ordinary Kjeldahl method.

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* Report N J. Exp. Station, 1898, page 98.

Note.—The original method has since been modified by the use of a 400 cc. beaker instead of a flask, the same to be immersed in boiling water during the digestion and covered with a cover glass. This modification facilitates manipulation and secures more uniformity of temperature during the digestion.

Inasmuch as this method has no official standing, in the following tables the name of the manufacturer of the material is in every case omitted :

	Per Cent. of Organic Nitrogen.	Percentage Availability.		Per Cent. of Organic Nitrogen.	Percentage Availability.
Dried Blood	12.41	95.6	Dried Blood	13.41	89.8
" "	13.20	95.2	" "	11.66	87.4
" "	13.11	95.2	Average	12.82	93.0
" "	14.01	95.0	Ground Horn	14.85	95.9
" "	12.85	94.6	Concentrated Tankage	11.13	93.7
" "	13.60	94.4	Ammonite	13.00	93.6
" "	13.78	94.3	"	12.83	95.4
" "	14.04	94.0			
" "	11.89	92.7	Average	12.92	94.5
" "	13.41	92.2	Cracklings	13.22	93.5
" "	11.63	91.9	Hoof Meal	14.47	92.2
" "	11.89	91.8	" "	14.04	89.7
" "	13.10	91.0	Average	14.26	91.0

The fifteen samples of dried blood examined range in availability from 87.4 to 95.6, with an average of 93.0 per cent. All of the higher-grade bloods, with one exception, show a somewhat higher degree of availability than those of lower grade (containing less than 12 per cent. of nitrogen). The average availability of the former is 93.7 and of the latter 91.0 per cent., which is due chiefly to the presence of considerable phosphoric acid in the latter, one sample showing as much as 3.44 per cent., thus indicating the admixture of some foreign matter, probably bone. These figures show that the dried blood on the market for the past three years has been of excellent quality and contains nitrogen in a very available form.

The other materials reported in the above table, ground horn, concentrated tankage, ammonite, cracklings and hoof meal, all show a

igh degree of availability. As stated in a previous report, the ample of ground horn is probably better than the average, as it was n old sample and in a very pulverulent condition. The samples of oof meal were submitted to a vegetation test at this station, and howed a relation to dried blood almost identical with the figures in he table. All of these materials furnish organic nitrogen in a very vailable form.

	Per Cent. of Organic Nitrogen.	Percentage Availability.		Per Cent. of Organic Nitrogen.	Percentage Availability.
ried Fish	10.28	92.9	Dried Fish	6.50	82.9
" "	8.34	90.7	" "	8.26	82.6
" "	8.56	90.7	" "	8.34	82.3
" "	8.78	90.2	" "	7.75	82.2
" "	9.38	90.1	" "	8.23	82.1
" "	7.97	90.0	" "	5.07	81.9
" "	8.22	89.9	" "	8.44	81.4
" "	7.53	88.7	" "	7.49	79.6
" "	8.80	88.5	" "	8.12	79.3
" "	8.39	88.2	" "	6.82	78.4
" "	8.39	88.2	" "	5.07	74.7
" "	9.53	88.0	" "	6.47	74.4
" "	8.69	87.6	" "	6.76	70.8
" "	7.39	87.1	" "	6.86	70.1
" "	6.82	86.7	" "	5.19	69.3
" "	8.28	86.5	" "	6.20	66.9
" "	8.83	86.3	" "	6.96	65.8
" "	9.43	86.1	" "	7.04	65.3
" "	4.57	86.0	" "	4.58	61.4
" "	8.37	85.0	" "	7.07	62.9
" "	7.80	84.7	" "	5.14	56.1
" "	7.61	83.5	Average	7.54	81.1

The forty-three samples of dried fish reported in the above table show wide variations in availability, ranging from 56.1 to 92.9 per cent. If we make a somewhat arbitrary division of the samples, classing those containing more than 7 per cent. of nitrogen as high-grade, and those below that figure as low-grade, we find that, with a

very few exceptions, these differences become much smaller, the average availability for the high-grade samples being 86.4 per cent., and that for the low-grade 72.3 per cent. The differences in the nitrogen availability of different samples of fish arise from the varying amounts of flesh, bone and oil which they contain, any excess of flesh showing itself in an increased nitrogen content, and any excess of bone or oil causing a lower percentage of nitrogen. These facts, together with the figures of the above table, show that, with a very few exceptions, in this class of goods the percentage of nitrogen contained is a fairly reliable guide as to the availability of the nitrogen. A wet, oily fish containing a large proportion of bone naturally would be less available to the plant than one whose chief constituent was fine dried flesh. The proportion of salt contained also has considerable influence on the usefulness of the fish to the growing plant.

	Per Cent. of Organic Nitrogen.	Percentage Availability.		Per Cent. of Organic Nitrogen.	Percentage Availability.
Tankage	8.68	93.2	Dissolved Bone	2.20	53.1
"	7.48	92.8	" "	1.95	62.7
"	6.90	91.5	Steamed Bone	2.78	87.0
"	5.00	91.2	" "	2.25	84.8
"	7.67	89.5	" "	2.20	81.9
"	7.20	89.2	Average	2.41	84.6
"	6.58	88.4	Button Bone	3.14	86.7
"	5.88	87.1	" "	3.33	84.0
"	6.42	85.4			
"	5.69	84.0	Average	3.24	85.4
"	6.65	81.8	Bone Sawings	3.80	79.7
"	5.67	79.8	" "	3.85	77.6
"	5.89	79.7	" "	3.93	76.0
"	5.34	79.7	Average	3.86	77.8
"	5.16	65.0	Soft Ground Bone	2.87	71.6
Average	6.41	85.2	Raw Ground Bone	3.93	70.0
Dissolved Tankage	5.02	65.9	" " "	3.40	66.9
" "	2.93	63.1	" " "	4.12	66.3
Average	3.98	64.5	" " "	4.05	66.2
Degelatinized Bone	0.54	87.3	Average	3.88	67.4

The fifteen samples of tankage show a variation in availability ranging from 93.2 to 65.0 per cent., with an average of 85.2 per cent. Like fish, tankage is a very variable material, as these figures show, but unlike fish, the percentage of nitrogen contained is of little value as indicating the nitrogen availability. The possibility of the manufacturer making his tankage a vehicle for the disposal of the crudest offal of the slaughter house, as is frequently done, makes it necessary for the consumer to use great care in its purchase. The percentage of phosphoric acid present (in the above samples, ranging from 8.02 to 18.06 per cent.), is a partial guide as to its source, but too much dependence cannot be placed on this, for while a high content of phosphoric acid is almost certain evidence that bone is an important constituent, a low content of phosphoric acid does not necessarily indicate that high-grade materials have been used in making up the tankage. The availability of the nitrogen of the two samples of dissolved tankage reported is somewhat lower than would be expected from experience with analagous materials.

In the above table are also grouped sixteen samples of bone representing seven classes of that product. The degelatinized bone, made by a patent process, shows a high degree of availability. This particular sample showed more than half of its total nitrogen in the form of ammonia salts, and its organic nitrogen appears also to be very available. The two samples of dissolved bone show a wide divergence. The sample called "soft ground bone" in appearance strongly resembles dissolved bone, and its availability shows it to belong to that class of materials. Of the remaining classes of bone shown in the table, steamed bone and button bone show the highest availability, while bone sawings and raw bone are considerably lower. The process of steaming removes the greater part of the fatty matter, and this probably accounts for its higher availability than the more crude forms. Likewise in button bone, the bone used for this purpose is almost completely freed of fat and consequently shows a high availability. Raw bone, containing as it usually does, considerable quantities of fatty matter, shows the lowest availability of any of the forms of bone examined.

	Per Cent of Organic Nitrogen.	Percentage Availability.		Per Cent of Organic Nitrogen.	Percentage Availability.
Castor Pomace	6.12	90.0	Wool Waste	2.47	54.9
Peanut Pulp	8.52	89.3	Average	2.46	71.3
Cottonseed Meal	6.81	82.6	King Crab	8.78	72.5
" "	7.38	79.6	" "	9.12	52.5
" "	6.74	78.6	Hair Manure	5.76	54.6
Average	6.79	80.3	Garbage Fertilizer	2.95	59.2
Linseed Meal	5.94	77.7	" "	3.20	44.1
Horse Meat	4.29	70.4	" "	2.99	42.7
Pigeon Manure	0.67	88.8	Average	3.05	48.7
Wool Waste	2.58	77.6	Burned Garbage	1.95	51.5
" "	2.84	75.6	Snuff Sand	1.08	48.3
" "	2.52	75.1	Steamed Leather	6.87	39.5
" "	2.51	75.0	Treated Leather	7.22	33.4
" "	2.31	69.8	Raw Leather	7.56	25.5

The above table shows the availability of the nitrogen in twenty-five samples, representing fifteen kinds of material. The figures obtained indicate that castor pomace, peanut pulp, pigeon manure, cottonseed meal and linseed meal should be classed with the high-grade ammoniates. The horse meal ranks with an inferior tankage, and the king crab with inferior fish, the availability of the second sample, however, being even several per cent. lower than the poorest fish reported. The samples of wool waste, with one exception, are very uniform both in composition and availability and occupy a place somewhat below fish, and an intermediate position between the good and the poor materials. The remaining materials are of known inferiority, and the availabilities they show under the action of permanganate indicate that the method is successful in differentiating the good and the bad materials. Three other samples of hair manure, besides the one reported in the table, were examined, but are excluded because of the uncertainty as to their origin. One sample contained as much as 10.48 per cent. of nitrogen, and this high nitrogen content together with the high availability shown (81.0, 85.8 and 93.2 per cent.) seemed to indicate that they did not fairly represent the material known as crude hair. Much treated

r has appeared for sale in recent years, particularly in southern rkets, and these samples may belong to that class, thus accounting the high availability shown. The snuff sands represents the eepings from a snuff factory, and the low availability, 48.3 per t., indicates that it is much inferior to the high-grade ammoni-s. The samples of garbage and those of leather, both in the ated and untreated form, occupy the lowest position of any of the nples examined.

The following table gives a summary of the average results ob-ned in the thirty-one classes of materials examined :

Average Availability of Organic Nitrogen.

	Percentage Availability.	Number of Analyses.		Percentage Availability.
Horn Meal	95.9	3	Cotton-seed Meal	80.3
Ammonite	94.5	3	Bone Sawings	77.8
Concentrated Tankage	93.7	1	Linseed Meal	77.7
Cracklings	93.5	1	Soft Ground Bone	71.6
Dried Blood	93.0	6	Wool Waste	71.3
Hoof Meal	91.0	1	Horse Meat	70.4
Castor Pomace	90.0	4	Raw Bone	67.4
Peanut Pulp	89.3	2	Dissolved Tankage	64.5
Pigeon Manure	88.8	2	King Crab	62.5
Degelatinized Bone	87.3	1	Hair Manure	54.6
Button Bone	85.4	1	Burned Garbage	51.5
Tankage	85.2	3	Garbage Fertilizer	48.7
Steamed Bone	81.6	1	Snuff Sand	48.3
Dissolved Bone	83.1	1	Steamed Leather	39.5
	62.7	1	Treated Leather	33.4
Dried Fish	81.1	1	Raw Leather	25.5

INVESTIGATIONS RELATIVE TO THE USE OF NITROGENOUS MATERIALS.

BY EDWARD B. VOORHEES.

Losses from Farmyard Manures When Allowed to Leach.

These experiments, while primarily planned to obtain data concerning the relative availability of nitrogen in farmyard manure of various kinds, and of the commercial nitrogenous products, admitted a study of the losses, both in fertility elements direct, in availability that may occur in the improper handling of cow manure made upon the farm.

That phase of the experiments which enabled a study of the losses that may occur through exposure, included four lots of manure, each lot including the solid excrement only, and the solid and liquid excrement combined. These were exposed for different periods and at different seasons of the year, thus making the average of the four lots fairly representative of the average period during which manure is most likely to be exposed, as well as representing manures made under different conditions of feeding, summer and winter. The manure was carefully collected, and 100 pounds of each lot placed in a galvanized iron box, 8 inches deep, with a perforated bottom, covered with wire gauze to prevent mechanical losses, and then exposed in the open air, as follows :

First lot, February 4th to June 5th, 1898.	A period	of	131	days.
Second lot, February 3d to April 13th, 1899.	"	"	70	"
Third lot, February 7th to April 20th, 1900.	"	"	76	"
Fourth lot, August 9th to September 27th, 1900.	"	"	50	"

In the next place, in order to eliminate unequal factors as far as possible, the manures used in the experiment were not mixed with litter or other substances, and hence the results may not be strictly comparable with those obtained under the average conditions of handling, where litter and absorbents are used ; nevertheless, the losses that occur and the availability of the material of different kinds would undoubtedly be relatively the same. For example, if it is shown that 40 per cent. of the nitrogen contained in solid manure is lost by exposure for a certain period, and 50 per cent. of the nitrogen in the solid and liquid manure is lost under the same conditions as

to time and season, the relations would be the same, even though the two kinds were admixed with other materials; or, in other words, the presence of an equal amount of litter would have practically the same effect upon one lot as upon another. Furthermore, if it were shown that the nitrogen in the fresh solid manure showed an availability for a crop or season of 15 per cent., and the availability of the nitrogen in the fresh solid and liquid manure was 40 per cent., the relative availability would be likely to be the same, even though the materials were admixed with other substances. It seemed best to study the two products, solid, and the solid and liquid combined, which would be relatively the same upon any farm, provided the feeding was the same, rather than a mixture of other materials, which would vary with the different producers.

Chemical analyses were made, both at the time the manures were placed in the boxes, and again at the end of the period. The losses calculated on the basis of the amount of constituents contained in 100 pounds of the dry matter of the original manure, are shown in Table I.

TABLE I.

Losses Sustained by Manures on Exposure.

Solid Manure.

Lot.	Period.		In 100 pounds of dry matter: Ash.	Organic matter.	Nitrogen.	Phosphoric acid.	Potash.
1.	181 days.	Original.........lbs.....	12.166	87.834	2.286	2.915	1.488
		Loss...............lbs.....	5.085	44.915	1.041	2.211	1.196
		Per cent ....lost...	41.8	51.1	46.0	72.0	80.0
2.	70 days.	Original.........lbs.....	15.607	84.393	2.094	2.215	1.262
		Loss ....lbs.....	5.369	20.631	0.705	0.591	0.133
		Per cent ....lost...	34.4	24.4	34.0	27.0	10.0
3.	76 days.	Original.........lbs.....	11.849	88.151	2.128	2.315	1.408
		Loss ....lbs.....	3.700	23.300	0.524	1.242	0.672
		Per cent ....lost..	31.2	26.4	25.0	54.0	48.0
4.	50 days.	Original.........lbs.....	17.507	82.493	2.383	1.873	0.859
		Loss...............lbs.....	7.114	36.386	1.076	0.793	0.365
		Per cent ....lost...	40.6	44.1	45.0	42.0	42.0
	Average original..........lbs.....		14.282	85.718	2.223	2.330	1.254
	Average loss.....................lbs.....		5.317	31.283	0.837	1.209	0.592
	Average per cent..........lost...		37.2	36.4	37.6	51.9	47.1

Solid and Liquid Manure Combined.

Lot.	Period.		Ash.	Organic matter.	Nitrogen.	Phosphoric acid.	Potash.
			In 100 pounds of dry matter				
1.	181 days.	Original.........lbs......	12.924	87.076	3.558	2.582	2.331
		Loss................lbs.....	3.601	35.398	2.010	1.594	1.684
		Per cent.........lost.....	27.8	40.6	57.0	62.0	72.0
2.	70 days.	Original.........lbs......	14.127	85.873	2.929	2.019	1.899
		Loss.... ....lbs.....	4.151	24.849	1.275	0.333	0.524
		Per cent.........lost.....	29.4	28.9	44.0	16.0	28.0
3.	76 days.	Original.........lbs......	13.687	86.313	3.576	2.321	1.845
		Loss...............lbs......	4.459	27.541	1.397	1.472	1.034
		Per cent.........lost.....	32.6	31.9	39.0	63.0	56.0
4.	50 days.	Original.........lbs.....	21.619	78.381	2.529	1.877	4.425
		Loss...............lbs.....	14.252	51.248	1.749	1.108	3.181
		Per cent.........lost.....	65.9	65.4	69.0	59.0	72.0
Average original............lbs......			15.589	84.411	3.147	2.200	2.625
Average loss.................lbs.....			6.616	34.759	1.605	1.125	1.606
Average per cent..........lost.....			42.4	41.2	51.0	51.1	61.1

It was possible to include in the study of losses the mineral constituents, phosphoric acid and potash, as well as the nitrogen; the experiment proper, however, did not include a study of their effect upon crop production, since an excess of these was added in all cases, in order to study the one question of the availability of the nitrogen.

In the first place, it is shown that there is a very considerable difference as to the rate of loss, influenced both by the length of time and the season during which it was exposed, as well as the character of the manure. In the case of the solid manure, the loss of nitrogen ranges from 25 per cent. in the third period, to 46 per cent. in the first period; the loss of phosphoric acid ranges from 27 per cent. in the second period, to 72 per cent, in the first period, and the loss of potash ranges from 10 per cent. in the second period, to 80 per cent. in the first period. In the case of the solid and liquid combined, the loss of the nitrogen ranges from 39 per cent. in the third period, to 69 per cent. in the fourth period; the loss of phosphoric acid ranges from 16 per cent. in the second period, to 63 per cent. in the third period, and the loss of potash ranges from 28 per cent. in the second period, to 72 per cent. in both the first and fourth periods. In the case of the nitrogen and potash the greatest loss occurred in the solid and liquid, while in the case of phosphoric acid the loss is practically identical, whether in the solid, or in the solid and liquid manure. Of the ash and organic matter, the greatest loss occurred in the case of the solid and liquid combined.

The average of all the experiments shows a loss in the solid manure 37.6 pounds from every hundred of nitrogen, 51.9 from every hun-d of phosphoric acid, and 47.1 pounds from every hundred of ash. In the solid and liquid combined, there was an average loss 51.0 pounds of nitrogen from every hundred contained in the ginal manure, 51.1 pounds from every hundred of phosphoric d, and 61.1 pounds from every hundred of potash, or nearly one-f of the total contained in the solid manure, and more than one-f of the total contained in the solid and liquid combined.

Vhat the Losses Represent in Plant-Food in Commercial Forms.

t does not follow that manures can be so handled as to prevent all this loss of constituents before they are applied to the land, par-ılarly in the case of the constituent nitrogen, because changes take ce very rapidly. Nevertheless, the greatest losses from both care-s and careful handling are liable to fall upon the solid and liquid nbined, rather than upon the solid portion, and, therefore, care uld be exercised to prevent the conditions which favor such loss. uming that the figures here obtained do represent the possible, or n maximum losses, the following calculations are of interest. The d and liquid manures represented in the experiments contained, the average :

Nitrogen	0.457	per cent.
Phosphoric acid	0 300	"
Potash	0.348	"

t has been shown by the records kept at the College Farm as the amount of manure product, that the average production of d and liquid manure, unmixed with litter, amounted to 70 ınds per day, or an equivalent of 12.78 tons per cow per year ; cows ranging in weight from 850 to 1,500 pounds, an average of ut 1,000 pounds. There would be contained, therefore, in the nure made in one year by a well-fed cow, 117 pounds of nitrogen, pounds of phosphoric acid and 89 pounds of potash. These con-uents are equivalent in amounts to what is contained in 731 ınds of nitrate of soda (16 per cent.), 550 pounds of acid phos-ate (14 per cent.) and 178 pounds of muriate of potash (50 per t). This amount of manure, if exposed for an average of 82 days ween February and October, would lose 60 pounds of nitrogen, of phosphoric acid and 54 of potash, or an equivalent of 380 unds of nitrate of soda, 277 of acid phosphate and 108 of muriate

of potash. Without regard to the value, there would have been lost these amounts of essential constituents. If the manure had been handled in the best manner, a part of the nitrogen contained might have been lost, because of the tendency to fermentation, resulting in the escape of ammonia, but the mineral constituents could have suffered no loss, without exposure to conditions which permit leaching. That losses of the constituents of manures do constantly occur is abundantly evident to anyone who observes the conditions obtaining on many dairy farms, for in both winter and summer the manures are allowed to lie in the open yard, often in loose heaps, which favor fermentation, and subjected to the leaching from every rain that falls. These conditions must result in great loss, and the probabilities are that the amounts annually lost are as great, if not greater, than is shown by these actual figures.

Value of the Constituents Lost.

It is difficult to affix a value to these constituents, since it is manifestly unfair to apply the same commercial values to the constituents contained in yard manure as are affixed to the constituents in commercial fertilizers, because commercially the conditions are different; yet, it is a fair assumption that if the constituents lost were replaced by those from regular commercial sources, it would cost exactly what commercial relations have fixed for these products. The amounts of the materials indicated as containing constituents equivalent to those lost would cost at the present time, at wholesale, unmixed, $12.50. If they were purchased in the form of New York manure, at prices at which the product is delivered at consumer's depots in the trucking districts, viz., $2 per ton, they would cost $11.50, or but slightly less than if purchased in commercial forms, though at a much greater expense for labor. From either standpoint the constituents possibly lost from the manure of one well-fed cow for one year represents a considerable financial outlay, if the loss is to be made good by purchased supplies. On the basis of the cost of constituents in commercial fertilizers, it is equivalent to 25 cents per hundred for the milk of a 5,000-pound cow, and 23 cents per hundred on the basis of the cost of New York manure. That is, if the fertility of the farm so lost was made good by the purchase of commercial fertilizer, or of New York manure, then the cost of production per hundred of milk would be increased by these amounts, and conversely, if the losses were prevented and the outlay not required, the cost per hundred of milk would be decreased by 25 and 23 cents, respectively.

EXPERIMENTS IN 1900.

THE COMPOSITION OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, FRESH.

The samples were obtained by collecting from a cow, well fed, a considerable amount of the solid manure, and of the solid and liquid manure, or total excrement. The samples were thoroughly mixed, and two pounds taken for analysis, which showed the following composition :

	Fresh Manure	
	A. Solid. Per cent.	B. Solid and Liquid. Per cent.
Water	85.011	85.095
Ash	1.776	2.040
Organic matter	13.213	12.865
Nitrogen (total)	0.319	0.533
" water-soluble	0.051	0.280
" as nitrates	....	....
" as ammonia	....	0.089
" as soluble organic	0.051	0.191
" as insoluble organic	0.268	0.253
Phosphoric acid	0.347	0.346
Potash	0.211	0.275

A study of the analyses shows that 0.051 per cent. of the solid and 0.280 per cent. of the solid and liquid manure was soluble nitrogen ; that is, 16 and 36 per cent., respectively, of the total nitrogen was soluble in water. The content of potash was nearly 68 per cent. greater in the combined solid and liquid manure. That is, the solid and liquid manure shows a higher percentage of the valuable constituents, not only, but a greater solubility of the nitrogen.

THE COMPOSITION OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, LEACHED.

For the purpose of leaching, 100 pounds of each of these fresh manures were collected and placed in galvanized-iron boxes, eight inches deep, and with a perforated bottom, so as to permit drainage, though covered with a wire gauze above and below, in order to prevent loss of solid matter. The boxes, with their contents, were placed in an exposed place in the open air, and allowed to remain undisturbed from February 2d to April 20th, a total period of

seventy-six days. As the temperature was too low in the months of February and March to cause any fermentation, the losses likely to occur would be due to a carrying away of the soluble constituents by the water from the rains passing through the boxes. On April 2d, the contents of the boxes were weighed, and it was found that the 100 pounds in the case of the solid manure had contracted to 73 pounds, and in the case of the solid and liquid to 68 pounds. Samples were again taken and analyses made as in the case of the fresh products. The results were as follows :

Composition of Manures on Water-Free Basis.

	Solid. Fresh. A. Per cent.	Solid and Liquid. Fresh. B. Per cent.	Solid. Leached. C. Per cent.	Solid and Liquid. Leached. D. Per cent.
Ash	11.849	13.687	11.163	13.570
Organic matter	88.151	86.313	88.837	86.430
Nitrogen (total)	2.128	3.576	2 197	3 204
" water-soluble	0.340	1.879	0.456	1.456
" as nitrates	....	....	....	....
" as ammonia	....	0.597	....	0.617
" as soluble organic	0.340	1.282	0.456	0.839
" as insoluble organic.	1.788	1.697	1.741	1.748
Phosphoric acid	2.315	2.321	1.470	1.248
Potash	1.408	2.321	1.008	1.193

Losses Sustained by Leaching.

	74 Pounds of C Contains,	Loss.	71 Pounds of D Contains,	Loss.
Ash	8.149	3.700	9.228	4.459
Organic matter	64.854	23 300	58.772	27.541
Nitrogen (total)	1 604	0.524	2.179	1.397
" water-soluble	0.333	0.007	0.990	0.889
" as nitrates	....	....	....	....
" as ammonia	....	....	0.420	0.177
" as soluble organic	0.333	0 007	0.570	0 712
" as insoluble organic.	1.271	0.517	1 189	0 508
Phosphoric acid	1.073	1.242	0.849	1.472
Potash	0.736	0.672	0.811	1.034

These calculations show that the losses were considerable; in sample C (solid manure), 25 per cent. of the nitrogen, 54 per cent. of the phosphoric acid and 48 per cent. of the potash were lost, while in sample D (solid and liquid manure), 39 per cent. of the nitrogen, 63 per cent. of the phosphoric acid and 56 per cent. of the potash were lost. The loss of ash in sample C was 31.2 per cent. compared with a loss of 32.6 per cent. in sample D, while the losses in organic matter were 26.4 per cent. in C, and 31.9 per cent. in D.

The nitrogen, as well as the mineral constituents remaining in the leached residues, consisted, therefore, of the less soluble portions of the manure. The composition of the fresh manure, and of the leached manures, used in the experiment, are shown in the accompanying table:

	Fresh Manures.		Leached Manures.	
	Solid. Per cent.	Solid and Liquid. Per cent.	Solid. Per cent.	Solid and Liquid. Per cent.
Water	84.901	84 368	81.152	80.214
Ash	2.109	2 356	2.104	2.685
Organic matter	12 990	13.276	16.744	17.101
Nitrogen (total)	0.325	0.515	0.414	0.634
" water-soluble	0.066	0.269	0.086	0.288
" as nitrates	......	......	......	......
" as ammonia	......	0 047	......	0.122
" as soluble organic	0.066	0.222	0.086	0.166
" as insoluble organic	0.259	0.246	0.328	0.346
Phosphoric acid	0.272	0.246	0.277	0.247
Potash	0.206	0.301	0.190	0.236

Description of the Experimental Plant.

In order that the conditions of the experiment might conform as nearly as possible to those in actual practice, what is known as the "cylinder method" was adopted. A full description of the plant has already been published*, and the diagram of experiments only is republished here.

*Annual Report N. J. Station, 1899, pages 104-106, inclusive.

Diagram of Experiment.

Series.	A	B	C
1. Check	○	○	○
2. Minerals	○	○	○
3. Manure, solid, fresh	○	○	○
4. Manure, solid and liquid, fresh	○	○	○
5. Manure, solid, leached	○	○	○
6. Manure, solid and liquid, leached	○	○	○
7. Nitrate of soda, 5 gms	○	○	○
8. Nitrate of soda, 10 gms	○	○	○
9. Manure, solid, fresh; nitrate, 5 gms.	○	○	○
10. Manure, solid, fresh; nitrate, 10 gms	○	○	○
11. Manure, solid and liqnid, fresh; nitrate, 5 gms	○	○	○
12. Manure, solid and liquid, fresh; nitrate, 10 gms	○	○	○
13. Manure, solid, leached; nitrate, 5 gms	○	○	○
14. Manure, solid, leached; nitrate, 10 gms	○	○	○
15. Manure, solid and liquid, leached; nitrate, 5 gms	○	○	○
16. Manure, solid and liquid, leached; nitrate, 10 gms	○	○	○
17. Sulfate of ammonia	○	○	○
18. Dried blood	○	○	○
19. Manure, solid, leached; sulfate of ammonia	○	○	○
20. Manure, solid, leached; dried blood	○	○	○

PLAN OF EXPERIMENTS.

Application of Manures and Fertilizers.

On April 26th, 1900, the manures and fertilizers were applied. he manures were carefully weighed and thoroughly incorporated ith the soil. About one-half of the soil was first removed from the linder; a portion of the manure was then taken and mixed as refully as possible with the remaining soil, then manure and soil lded from time to time until all of the manure had been used. bout one inch of soil was placed upon the surface of the whole in der to prevent any changes in the manure due to exposure. The mmercial fertilizers were also applied at the same time and in the me way.

Amounts Applied.

It was the aim to have the different kinds of manure applied iiform in amount and slightly greater than would be used in dinary practice, and corresponding with that frequently used in arket gardening. The applications were in no case so excessive as render the conditions different from those obtaining in good farm actice, or at the rate of 16 tons per acre.

In the case of the nitrogen in artificial forms, the nitrates only ere applied in two different quantities, in the one case 5 grams per linder, equivalent to 160 pounds per acre, which may be regarded a medium, and in the second, 10 grams per cylinder, equivalent 320 pounds per acre, or a large application. This was done in der that the effect of dentrification, if any, might be more fully udied. In the case of the ammonia and blood, an amount of trogen equivalent to that in the larger quantities of nitrate was plied.

The Crops Grown.

After the crops were removed from the cylinders in 1899, the surce soil was kept free from weeds, and on April 28th, 1900, oats of e Clydesdale variety were planted in the group of cylinders conining the medium clay loam. The seed was uniform in size of ain, and 100 were placed in each cylinder. The crops on all the ries grew rapidly and were photographed July 5th, and harvested ly 6th, on which date the grains were fully formed and in the ough stage.

After the removal of the oats, the soil was loosened, and corn planted thickly (20 grains in each cylinder), in order to gather as far as possible the residual nitrogen. The seed did not germinate well, and the millet was replanted on July 16th, and harvested when the plants on the well-manured cylinders were fully headed.

On the sandy loam cylinders a single sweet potato plant was set in each cylinder. Plants of the Jersey variety were planted in the greenhouse March 15th, slipped into cans and transplanted to the cylinders on May 18th. They started immediately, and grew well throughout the early season. The crops in both cases were carefully watched and watered three times during the season of growth, using 14 pounds in each application. The oats were supported with wire frames to keep them upright and prevent injury from winds; the leaves which dropped were gathered and included in the sample.

Very marked differences were noted in the growth of the crops. The oats in series 4, 7, 8, 11 and 12, showed the greatest vigor and most rapid growth. Those in the check series and in series 2 and 3, were yellow and sickly and grew very slowly in the early season, though proportionately more rapidly late in the season, or after the others had headed. It is believed that if the crop had been harvested a month earlier much greater gains over check plots would have been observed.

The same statements hold true for the potatoes. On September 7th the crop was harvested, and wide variations in the crops of the different series were noticed. The variations in the yields on the plots of the same series were slight, and the experiment corresponded directly with that of 1899. In a few cases in the potato experiment, such wide variations were observed as to make it inadvisable to report the results at present. The work is, however, suggestive, and enables a study of the variations that may be expected in crops of this sort.

The Results of the Oat Experiment—1900.

The accompanying table shows the actual dry matter in the different crops, the percentage of nitrogen contained in them, the gain in nitrogen due to materials added, and the percentage of the applied nitrogen recovered. In all cases the net gains in the different series are derived by subtracting the average gain obtained on series 2, upon which minerals only were applied, from the average gain for that particular series.

As in the crops of 1898 and 1899, there was a gain in weight of the dry matter of the crops to which nitrogenous materials were applied. Series 1, to which nothing was added, and series 2, to which minerals only were added, give us some interesting figures. While the quantities of nitrogen removed by the crop from series 1 and 2 differ but little, being 1.103 grams and 1.152 grams, respectively; yet the amounts of dry matter produced from that nitrogen show striking differences. The average amount of dry matter on series 1 was 83.1 grams; on series 2 it was 110.3 grams, taking the amount of nitrogen in the crop from series 1 as 100, the nitrogen obtained from 2, would be 104, nearly; and taking the average weight of the dry matter from series 1 as 100, the average weight of the dry matter from series 2 would be 133, nearly. Evidently the plants on series 2, thanks to the abundance of available potash and phosphoric acid, were able to employ to better advantage the limited amount of nitrogen at their disposal. A more detailed study of the yields on plots 1 and 2 for the past three years is presented elsewhere in this report, and an attempt is made to explain the variations more fully. The variations in the yield of dry matter in each series are not as great as was the case in the corn in 1898, they are practically the same as in the oats in 1899. As shown in Table A, the average variation in 1898 was 15.35 per cent., the maximum being 37.8 per cent in series 2. The average variations in 1899 and 1900 were 9.64 per cent. and 9.72 per cent., respectively, and the maximum variations were 25.2 per cent. in series 17 in 1899, and 25.5 per cent. in series 3 in 1900. These results indicate that the differences in the soils were more or less equalized during the first season, and hence the more uniform results in 1899 and 1900.

Results of the Oat Experiment.

SERIES.	Nitrogen applied.	Dry matter in crop.	Nitrogen in dry matter.	Nitrogen in crop.	Increase over check plot.	Per cent. of nitrogen recovered.	Average per cent. of nitrogen recovered.
	gms.	gms.	%	gms.	gms.		
1 A		81.8	1.897	1.148			
B		82.6	1.818	1.085			
C		84.8	1.298	1.096			
2 A		116.9	1.018	1.190			
B		106.8	1.061	1.188	(1.152)		
C		107.1	1.058	1.188			
3 A	4.05	164.0	1.061	1.684	0.482	11.90	
B		155.8	1.108	1.721	0.569	14.05	10.81
C		128.8	1.142	1.414	0.262	6.47	
4 A	3.98	282.4	1.148	2.656	1.504	37.78	
B		208.8	1.069	2.227	1.075	27.01	30.60
C		218.8	1.044	2.227	1.075	27.01	
5 A	3.99	128.5	1.145	1.471	0.319	7.99	
B		121.7	1.121	1.364	0.212	5.31	7.38
C		131.2	1.147	1.506	0.353	8.85	
6 A	4.04	193.4	1.096	2.120	0.968	23.96	
B		193.7	1.067	2.067	0.915	22.65	22.06
C		193.7	1.008	1.943	0.791	19.58	
7 A	0.78	158.0	1.168	1.838	0.686	87.95	
B		166.3	1.035	1.720	0.568	72.82	80.43
C		174.7	1.019	1.780	0.628	80.51	
8 A	1.55	202.3	1.178	2.383	1.231	79.42	
B		184.0	1.252	2.304	1.152	74.32	76.30
C		198.4	1.168	2.317	1.165	75.16	
9 A	4.83	197.3	1.085	2.132	0.980	20.29	
B		189.5	1.119	2.121	0.969	20.06	19.97
C		199.2	1.052	2.096	0.944	19.55	
10 A	5.60	207.0	1.251	2.590	1.438	25.68	
B		227.2	1.316	2.991	1.838	32.82	27.99
C		232.9	1.107	2.578	1.426	25.46	
11 A	4.76	265.4	1.277	3.389	2.237	47.00	
B		260.1	1.077	2.801	1.649	34.64	41.43
C		269.0	1.183	3.182	2.030	42.65	
12 A	5.53	262.5	1.428	3.949	2.797	50.58	
B		242.2	1.436	3.478	2.326	42.06	44.68
C		285.9	1.204	3.442	2.290	41.41	
13 A	4.77	173.6	1.150	2.004	0.852	17.86	
B		169.8	1.143	1.941	0.789	16.54	17.50
C		178.5	1.129	2.015	0.863	18.09	
14 A	5.54	192.6	1.333	2.567	1.415	25.54	
B		206.4	1.208	2.488	1.331	24.03	24.25
C		196.4	1.241	2.437	1.285	23.19	
15 A	4.82	217.5	1.335	2.904	1.752	36.35	
B		211.5	1.236	2.624	1.472	30.54	31.71
C		217.0	1.158	2.513	1.361	28.24	
16 A	5.59	257.4	1.418	3.650	2.498	44.69	
B		230.4	1.420	3.272	2.120	37.75	38.32
C		214.1	1.387	2.970	1.818	32.52	
17 A	1.52	194.5	1.142	2.221	1.069	70.33	
B		178.3	1.221	2.177	1.025	67.43	68.84
C		191.2	1.149	2.197	1.045	68.75	
18 A	1.49	173.6	1.094	1.899	0.747	50.13	
B		187.3	1.060	1.985	0.833	55.91	52.15
C		175.4	1.085	1.903	0.751	50.40	
19 A	5.51	177.4	1.176	2.086	0.934	16.95	
B		197.9	1.235	2.444	1.292	23.50	20.63
C		201.3	1.156	2.333	1.181	21.43	
20 A	5.48	189.5	1.154	2.187	1.035	18.89	
B		179.2	1.200	2.150	0.998	18.21	19.20
C		198.7	1.145	2.275	1.123	20.49	

TABLE A.

Greatest Variation in the Yield of Dry Matter in Each Series.

	Corn—1898.		Oats—1899.		Oats—1900.	
Series.	Gms.	Per cent.	Gms.	Per cent.	Gms.	Per cent.
1	44.4	=22.7	8.7	=17.5	3 0	= 3.7
2	95.9	=37.8	4 8	= 8 5	10.1	= 9.4
3	57.4	=18.7	15.8	=21.1	31.5	=25.5
4	24.4	= 5.4	5.7	= 2.9	24.1	=11.5
5	101.3	=29.8	7.1	= 9.9	9.5	= 7.8
6	61.9	=17.2	15.1	=13 8	0.3	= 0.1
7	6.5	= 1.9	15.8	=15.2	16.7	=10.6
8	35.7	= 9.9	1.8	= 1.3	18.3	= 9.9
9	44.9	=13.1	17 3	=15.5	9.7	= 5.1
10	16.3	= 4.2	9.0	= 5.7	25.9	=12.5
11	45.3	= 9 8	6.7	= 3.2	8.9	= 3.4
12	10 0	= 2.0	28 0	=14.7	43.7	=18.0
13	115.4	=30.8	6.2	= 5.6	8 8	= 5.2
14	97.1	=23.4	22.5	=15.9	13.8	= 7.2
15	32.2	= 8.9	5.7	= 3.9	6.0	= 2.8
16	57 3	=15.8	4.7	= 2.8	43.3	=20.2
17	70.9	=21.5	25.2	=25.2	16.2	= 9.1
18	33 1	=12.5	5.0	= 4.8	13.7	= 7.9
19	33.4	= 8 2	3.7	= 2.9	24.4	=13.7
20	48.3	=13.4	2.9	= 2.5	19.5	=10.9
Average percentage variation		15.35		9.64		9.72

Average Amount of Dry Matter in Crop—1900.

Series.	Oats—grams.	Corn—grams.
1	83.1	129.2
2	110.3	127.8
3	144.4	190.4
4	218.0	179.8
5	127.1	191.0
6	193.6	152.6
7	166.3	109.5
8	194.9	121.3
9	195 0	187.8
10	222.4	209.9
11	264.8	179.6
12	263.5	193.0
13	175.2	221.3
14	198.5	198.2
15	215.3	186.2
16	233.9	185.6
17	188.0	113.5
18	178.8	126.1
19	192.3	174.1
20	189.1	176.2

As to the nitrogen content of the dry matter, the results in the main agree with those of last year. Two tendencies, at least, are indicated, namely, the production of plants rich in nitrogen, both on soils poor in nitrogen and other plant-food and on soils rich in nitrogen, and rich also in potash and phosphoric acid. Table B shows the average percentages of nitrogen contained in the crops of 1899 and 1900. In both oat crops the dry matter in series 10, 12, 14 and 16 is, with one exception, proportionately richer in nitrogen than the average of the other series; and, in the one exception also, the crops planted to secure the residual nitrogen after the oats, produced dry matter poorer in nitrogen than the average of the 19 series (series 1 being excluded). Thus the average content of nitrogen in the dry matter of the oats of 1899 was 1.407 per cent., and of the dry matter of the millet following the oats was 1.278 per cent. On the other hand, the nitrogen content of the dry matter in the oats of 1900 was 1.168 per cent., and that of the corn following, .626 per cent. The following figures present the above facts in tabulated form :

	1899.			1900.	
	Oats. Per cent.	Millet. Per cent.		Oats. Per cent.	Corn. Per cent.
Series 10	1.409	1.234		1.225	.584
" 12	2 011	1.132		1.356	.611
" 14	1.359	1.115		1.259	.594
" 16	1.509	1.493	(*1.185)	1.409	.592

Average for the oats ...... 1.407 per cent. Average for the oats .... 1.168 per cent.
" " millet... 1.278 " " " corn..... 0.626 "

It should be pointed out here that in the millet of series 16, one of the plots was defective, its yield of dry matter being only 66.6 grams as against 126.7 grams and 110.2 grams, respectively, in the other two plots. Furthermore, the nitrogen content of the dry matter on the first plot was 1.863 per cent., as against 1.165 per cent., and 1.200 per cent., respectively, on the other two plots. For these reasons we can arrive at the facts more readily by taking the average of only two of the plots in this particular series. Now, in the four series given here, there was a large amount of available nitrogen, there having been applied in each case 10 grams of nitrate of soda, besides the manure in one form or another. Similarly in series 1, there was a yield of substance richer in nitrogen than the average, as the following figures show :

*Average of two plots.

	1899		1900	
	Oats. Per cent.	Millet. Per cent.	Oats. Per cent.	Corn. Per cent.
Series 1....	1.460	2.514	1.334	.667

Average for the oats......	1.407 per cent.	Average for the oats......	1.168 per cent.
" " millet....	1.278 "	" " corn......	.626 "

These figures bear out the statement made above, that on soils poor in nitrogen, and also in potash and phosphoric acid, as well as on soils rich in available potash and phosphoric acid, and also rich in available nitrogen, there is produced under certain conditions plant substance rich in nitrogen.

In studying the data on Table B, one notices at once that the dry matter of the oat crop of 1899 was in *every* case richer in nitrogen than that of 1900, thus the average content of nitrogen in the dry matter was for all the series 1.410 per cent. in 1899, and 1.177 per cent. in 1900. Table C brings out the same fact in a somewhat different way. It shows the amount of dry matter produced from one gram of assimilated nitrogen in each series for the years 1898, 1899 and 1900. The crop of 1898 was corn, and is not comparable with the others, except in so far as to bring out the relations of the different manures to one another. The crops of 1899 and of 1900, are, however, the same; the length of their growing season was the same (April 15th to June 24th, in 1899, and April 28th to July 6th, in 1900); their treatment was the same. And yet, as shown in Table C, there was more dry matter produced from every gram of nitrogen in the crop in 1900, than there was in 1899, and that without exception. From 1 gram of nitrogen in the crop, there was produced 71.0 grams of dry matter in 1899, and 86.2 grams of dry matter in 1900, these representing the average in all the series. In other words, every gram of nitrogen in the crop produced over 21 per cent. of dry matter more in 1900 than the same amount of nitrogen produced in 1899. Moreover, not alone was there better use made of the nitrogen assimilated, but the *absolute* amount of nitrogen taken out of the soil was greater in 1900 than in 1899. The average amount taken out in each series was 2.208 grams in 1900, and 1.874 in 1899, a difference of more than 17 per cent. A comparative study of these relations is presented on Table D. This table shows that in every case but three, the absolute amount of nitrogen taken out by the oat crop of 1900 exceeded that taken out by the same crop

TABLE B.

Average Percentage of Nitrogen Contained in Dry Matter

Series.	Oats—1900. Per cent.	Oats—1899. Per cent.	Corn—1900. Per cent.	Millet—1899 Per cent.
1	1.334	1.460	.667	2.514
2	1.045	1.375	.623	1.223
3	1.104	1.345	.608	1.176
4	1.085	1.494	.622	1.160
5	1.138	1.303	.609	1.239
6	1.055	1.251	.653	1.322
7	1.072	1.268	.668	1.300
8	1.199	1.330	.641	1.425
9	1.085	1.253	.629	1.441
10	1.225	1.409	.584	1.234
11	1.179	1.725	.619	1.291
12	1.356	2.011	.611	1.132
13	1.141	1.232	.565	1.143
14	1.259	1.359	.594	1.115
15	1.243	1.313	.615	1.256
16	1.408	1.509	.592	1.409
17	1.171	1.394	.666	1.331
18	1.079	1.366	.662	1.305
19	1.189	1.402	.659	1.283
20	1.166	1.399	.678	1.493

TABLE C.

Amount of Dry Matter Produced by One Gram of Nitrogen in the Crop.

Series.	Corn—1898. Grams.	Oats—1899. Grams.	Oats—1900. Grams.
1	123.4	68.6	74.9
2	155.6	71.6	95.7
3	133.6	74.3	90.8
4	151.7	67.7	92.1
5	151.0	64.6	87.8
6	155.9	79.7	94.7
7	131.6	78.7	93.5
8	154.7	75.1	83.4
9	150.5	80.8	92.3
10	142.1	71.2	81.8
11	141.6	57.9	84.8
12	126.2	49.7	72.7
13	148.6	80.4	88.4
14	141.9	73.7	79.5
15	145.1	76.1	91.7
16	119.6	66.2	70.9
17	143.4	67.7	85.5
18	136.7	73.2	92.7
19	137.8	71.5	84.1
20	147.8	71.7	85.8
Average	......	71.0	86.2

TABLE D.

Average Amount of Nitrogen.

Series.	Oats—1899. Grams.	Oats—1900. Grams.	Excess over 1899. Grams	Per cent.
1	.789	1.108	+.319 =	40.4
2	.831	1.152	+.321 =	38.7
3	1.106	1.589	+.483 =	43.7
4	2.938	2.370	—.568 =	23.9
5	.996	1.447	+.451 =	45.3
6	1.455	2.043	+.558 =	40.4
7	1.422	1.797	+.375 =	26.3
8	1.901	2.335	+.434 =	22.8
9	1.505	2.116	+.611 =	40.6
10	2.260	2.719	+.459 =	20.3
11	3.635	3.124	—.511 =	16.3
12	4.022	3.623	—.399 =	11.0
13	1.413	1.987	+.574 =	40.7
14	2.064	2.496	+.432 =	20.9
15	1.978	2.347	+.369 =	18.6
16	2.596	3.297	+.701 =	27.0
17	1.645	2.198	+.553 =	33.6
18	1.457	1.929	+.472 =	32.4
19	1.829	2.288	+.459 =	25.1
20	1.650	2.204	+.554 =	33.6
Average	1.874	2.208		

TABLE E.

Amounts of Nitrogen Applied.

Series.	Oats—1899. Grams.	Oats—1900. Grams.	Excess over 1899. Grams.	Per cent.
1	......	......	....	......
2	......	......	....	......
3	3.32	4.05	+ .73 =	22.0
4	5.25	3.98	—1.27 =	31.9
5	1.96	3.99	+2.03 =	103.6
6	4.52	4.04	—0.48 =	11.9
7	0.78	0.78	....	......
8	1.55	1.55	....	......
9	4.10	4.83	+0.73 =	17.8
10	4.87	5.60	+0.73 =	15.0
11	6.03	4.76	—1.27 =	26.7
12	6.80	5.53	—1.27 =	23.0
13	2.74	4.77	+2.03 =	74.1
14	3.51	5.54	+2.03 =	57.8
15	5.30	4.82	—0.48 =	10.0
16	6.07	5.59	—0.48 =	8.6
17	1.62	1.52	—0.10 =	6.5
18	1.55	1.49	—0.06 =	4.0
19	3.58	5.51	+1.93 =	54.0
20	3.51	5.48	+1.97 =	56.1

in 1899. As to these exceptions, it should be noted here that series 4, 11 and 12 had considerable more nitrogen applied on them in 1899 than they had in 1900. Following are the figures:

	Oats—1899.		Oats—1900.		Excess over 1900.	
	Nitrogen applied.	Nitrogen in crop.	Nitrogen applied.	Nitrogen in crop.	Nitrogen applied.	Nitrogen in crop.
	gms.	gms.	gms.	gms.	%	%
Series 4..........	5.25	2.938	3.98	2.370	32	24
" 11..........	6.03	3.635	4.76	3.124	27	16
" 12..........	6.80	4.022	5.53	3.623	23	11

It will be seen, then, that in the three series the larger amount applied were partly responsible for the greater absolute amount recovered in 1899. We say *partly* advisedly, for, as will b seen later, there is still another factor which can help us t explain the problem. A further study of Table D, in conjunc tion with Table E, will bring out the same facts more clearly Let us take series 1, 2, 7, 8, 17 and 18, and examine th results obtained. It is evident that these are comparable in th series named, for the treatment in each case was the same. I series 1 and 2 no nitrogen was applied, on series 7 and 8 there wa applied 5 and 10 grams, respectively, of sodium nitrate, and on 1 and 18, sulphate of ammonia and dried blood were applied in th order named. Now, what do we find? We find that on series 1 an 2 there was obtained in 1900 40.4 per cent. and 37.7 per cent., re spectively, more nitrogen than was obtained in 1899 from the sam series. Again, on 7 and 8, there was obtained 26.3 per cent. an 22.8 per cent. more of nitrogen in 1900 than was the case in 1899 and similarly, on 17 and 18, 33.6 per cent. and 32.4 per cent. mor were obtained. And it should be noted here that in 1899 slightl larger quantities of nitrogen were used on 17 and 18, the figures bein 1.62 and 1.55 grams, as against 1.52 and 1.49 grams in 1900. Fur thermore, out of the eight series (4, 6, 11, 12, 15, 16, 17 and 18) o which more nitrogen was used in 1899 than there was in 1900, onl three gave a greater return of nitrogen as against the yield of 1900.

To return again to table C, it should be noted that there is a strik ing uniformity in the relations pointed out here. It is the propor tionate amount of nitrogen in the crop as compared with the amount of nitrate applied. In the oat crops of 1899 and 1900, the dr matter is invariably richer in nitrogen where ten grams of nitrat were used, than is the dry matter on the series where only 5 gram were used. Thus in 7 and 8 there was 1 gram of nitrogen in ever

78.7 grams of dry matter for the former, and 75.1 grams for the latter. In 1900, in the same series, it was 93.5 and 83.4. In 9 and 10 it was 80.8 and 71.2 for 1899, and 92.3 and 81.8 for 1900. In 11 and 12 it was 57.9 and 49.7 in 1899, and 84.8 and 72.7 in 1900. The same relations hold good in 13 and 14, and 15 and 16. It should also be pointed out, in connection with table C, that the solid, fresh, allowed a more economical use of the nitrogen assimilated than did the solid, leached ; and also that the solid and liquid, leached, allowed a more economical use of the nitrogen assimilated than did the solid and liquid, fresh. And, further, the nitrogen assimilated from the dried blood was more economically used in the oat crops of 1899 and 1900 than was the nitrogen assimilated from the ammonium sulphate.

Having noted the relations existing between the different manures, it is pertinent here to attempt an explanation of the problem stated above, namely, "why was there more dry matter produced in 1900 for every gram of nitrogen assimilated than was the case in 1899?" A comparison of the precipitation for the growing season of 1899 and 1900 will give us the information required.

Growing Season April 15th–June 24th, 1899.
Precipitation in Inches.

April	16th	.29	inches.
"	26th	.06	"
May	2d	.45	"
"	3d	.07	"
"	9th	.06	"
"	11th	.55	"
"	13th	.02	"
"	14th	.01	"
"	16th	.08	"
"	17th	.45	"
"	18th	.02	"
"	19th	.03	"
"	23d	.29	"
"	28th	.08	"
"	30th	.14	"
June	9th	.23	"
"	10th	.19	"
"	16th	.26	"
"	21st	1.95	"
Total		4.88	

Growing Season April 28th–July 6th 1900.
Precipitation in Inches.

May	3d	.01	inches.
"	4th	.39	"
"	5th	.03	"
"	9th	.25	"
"	13th	.20	"
"	18th	.25	"
"	19th	3.10	"
"	20th	.30	"
"	25th	.94	"
"	26th	.04	"
"	31st	.07	"
June	2d	.75	"
"	3d	.01	"
"	4th	.06	"
"	9th	.51	"
"	12th	.10	"
"	14th	.04	"
"	15th	.73	"
"	17th	.32	"
"	18th	.01	"
"	27th	.03	"
"	28th	.08	"
July	4th	.04	"
"	5th	.05	"
Total		8.31	

It will be seen that the total rainfall for the growing period was 4.88 inches in 1899, as against 8.31 inches in 1900. However, the amount given for 1899 is too high, since the oats were harvested on the 24th of June, thus making the 1.95 inches of rain that fell on the 21st of but little value to the crop. Moreover, the applications of water to the crops when they seemed to need it was not exactly the same for the two seasons. In 1899, the cylinders had water applied to them three times (about 6 quarts each time), the dates of application being June 1st, June 5th and June 17th. In 1900, there were four applications made, the same amounts being applied as in 1899, except at the fourth application, when 9 quarts were used. The dates of application were June 13th, 22d, 25th and 28th.

THE AVAILABILITY OF THE NITROGEN IN THE SOLID AND IN THE SOLID AND LIQUID PORTIONS OF FRESH MANURE.

In 1899, the problem was more complicated because of the varying quantities of nitrogen applied in the manure.* Such was not the case, however, in the crop under consideration, for the amounts of nitrogen applied in the manure were practically uniform. In every case where manure was used, enough was applied to furnish nitrogen practically equivalent to 4 grams.

1899.		1900.	
Series 3, nitrogen applied	3.32 gr.	Nitrogen applied.	4.05 gr.
" 4, " "	5.25 "	" "	3.98 "
Recovered in crop 3	8.3 %.	Recovered in crop...............	10.81 %.
" " " 4.................	40.2 "	" " "	30.60 "

It appears, then, that in each case the recovery from the solid and liquid, combined, was greater than that from the solid manure alone. However, the relations are not quite the same; for in 1899 the recovery from the solid and liquid was nearly five times that from the solid alone, while in 1900, the recovery from the solid and liquid, combined, was not quite three times that from the solid alone. The fact that the comparative recovery was greater from the solid manure alone, indicates that the greater amounts of moisture rendered greater quantities available. As with the results of 1899, it is quite evident here that a large recovery may be expected from the soluble nitrogen in liquid manures.

*Twenty-first Annual Report N. J. Experiment Station.

The greater yield of dry matter over check series 2 was 31 per cent. for the solid, and 97.6 per cent. for the solid and liquid. The corresponding figures for 1899 were 35.9 per cent. and 228.8 per cent. This again indicates that with more rain the solid manure makes a better showing. It should be borne in mind, nevertheless, that the better showing for the solid and liquid manure in 1899 was due in a measure to the larger application of 5.25 grams, as against 3.98 grams in 1900.

THE AVAILABILITY OF THE NITROGEN IN THE SOLID AND IN THE SOLID AND LIQUID MANURE, LEACHED.

As in the solid and solid and liquid manure, fresh, the leached manures were applied in unequal quantities in 1899, and in practically the same quantities in 1900. Following are the figures :

	1899.		1900.	
Nitrogen applied in leached manures,	Series. 5	1.96 grams.	Series 5	3.99 grams.
" " " " "	" 6	4.52 "	" 6	4.04 "
Recovered in crop	" 5	8.4 per cent.	" 5	7.38 per cent.
" " "	" 6	13.8 "	" 6	22.06 "

The differences in recovery in the leached manures between the solid, and solid and liquid portions, are not as great as in the fresh manures. The recovery in the solid leached is proportionately somewhat less in 1900, but in the solid and liquid leached the recovery in 1900 is much greater than that in 1899. In the preceding year, however, the recovery in the leached manures is less than the recovery in the fresh manures; while the differences in recovery between the solid fresh and leached are slight, the differences between the solid and liquid, leached and fresh, are more considerable.

As to the dry matter produced, following are the figures :

1899.		1900.	
Series 5	20.9 per cent.	Series 5	15.7 per cent.
" 6	83.3 "	" 6	57.7 "

It appears from these that in 1899, the increased yield over the check plot was greater in the case of the solid, and of the solid and liquid, leached. Also here it is evident that the differences in yield from the solid and the solid and liquid, leached, are not as great as they were in 1899. Furthermore, the dry matter produced from the solid manure, leached, is proportionately richer in nitrogen than the dry matter produced from the solid and liquid manure, leached. This is true for both 1899 and 1900.

THE RELATIVE AVAILABILITY OF THE NITROGEN IN THE FORM OF NITRATE, AMMONIA AND OF ORGANIC MATTER IN DRIED BLOOD.

The same amounts of nitrate nitrogen, of ammonia and of organic nitrogen, as dried blood, were applied on the several series, as in the years 1898 and 1899. Series 8, 10, 12, 14 and 16 received each the double quantity, that is, an amount of sodium nitrate containing 1.55 grams of nitrogen; series 7 received 0.78 grams of nitrate nitrogen. On 17 and 18, enough ammonium sulfate and dried blood, respectively, were applied to furnish, approximately, the double nitrate quantity of 1.55 grams of nitrogen. The basis of comparison, therefore, will be series 8. As in 1899, the proportionate recovery from series 8 is slighter than that from series 7. The differences, however, are somewhat smaller. The amounts recovered for 7 and 8 are 75.8 per cent. and 69.0 per cent., respectively, the corresponding figures for 1900 being 80.43 and 76.30 per cent. It would seem that the heavy showers in 1900 did not wash the nitrate beyond the reach of the crop. The dry matter in 1900, as was also the case in 1899, is richer in nitrogen on series 8. In 1899 it was 1.268 per cent., series 7, and 1.330 per cent. for series 8, and in 1900, 1.072 per cent. for 7, and 1.199 per cent. for series 8. The absolute amount of nitrogen taken out is, naturally enough, greater on series 8 than it is on series 7. In 1899 it was 1.422 grams on 7, and 1.901 grams on 8; a greater proportionate increase on 7, and a greater absolute increase on 8, as was already pointed out in Table D.

The dry matter on series 17, where sulfate of ammonia was used, is richer in nitrogen than the dry matter on series 18, where dried blood was used. The corresponding figures are 1.171 per cent. for 17, and 1.079 per cent. for 18, in 1900, as compared with 1.394 per cent. for 17 and 1.366 per cent. for 18, in 1899. It will be noticed that the differences are slighter in 1899. The percentage of nitrogen recovered is greater from the ammonia than it is from the dried blood, which is in agreement with the results of 1899. As with the nitrate, the percentage recovery from the sulfate of ammonia and from the dried blood, was greater in 1900. The recovery in 1899 was 50.3 for the sulfate of ammonia, and 40.4 per cent. for the dried blood. The corresponding figures for 1900 are 68.84 per cent. and 52.15 per cent.; also due, no doubt, to a more generous supply of moisture. It thus follows that the availability of the ammonia and blood

nitrogen was increased by the greater precipitation. It is interesting to note here, that the recovery from the dried blood in 1900 was greater than that from the sulfate of ammonia in 1899, both relatively and absolutely.

THE EFFECT OF THE USE OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, FRESH AND LEACHED, WITH NITROGEN IN THE FORM OF NITRATE, OF AMMONIA AND OF ORGANIC MATTER.

The object of these combinations was not alone the study of the availability of the different forms of nitrogen when applied together; but also to determine whether the nitrogen of the nitrates applied as such, or formed from the materials applied, would be set free by the deoxidizing action of certain bacteria.* As in previous years, the clear manure, free from any admixture of litter was used, and the amount of manure applied was in no case much greater than that applied in actual practice.

By applying the different forms singly and also in combination, it becomes possible to determine, not only the comparative availability, but also the extent of denitrification, if any should take place. The results of 1898, and of 1899, have shown clearly that, thanks to the combination, the nitrogen in the different forms is even more efficient than where these forms are used singly. The reason for this we must seek in the fact that no single form is so well adapted to nourish the plant continually and uniformly as are the proper combinations. Such uniform feeding not only enables a uniform and healthy growth, but it also makes possible a more thorough utilization of the plant food made available by providing a better root system. It should also be remembered that the character of the season is an important factor in determining the relative availability of the different forms of nitrogen. A more abundant supply of moisture will tend to increase the availability of the organic forms, and will also tend to increase to a still greater extent, proportionately, the availability of the nitrogen in the different combinations. However, while the tendency is there, the combinations do not always show a proportionate increase over the forms used singly. The following table shows the actual average percentage recovery of nitrogen, when the materials

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*N. J. Station Report 1899, pp. 97-101; 1900, pp. 100-102.

furnishing it were used singly, as well as when they were used in combination, together with the percentage increase of nitrogen from combinations of two materials, calculated from the increase obtained when they were used singly.

	No. of Series.	1899 Nitrogen Recovered. Per cent.	1899 Calculated Recovery. Per cent.	1899 Nitrogen not Recovered in the Combinations of Materials. Per cent.	1900 Nitrogen Recovered. Per cent.	1900 Calculated Recovery. Per cent.	1900 Nitrogen not Recovered in the Combinations of Material. Per cent.
Solid manure, fresh.........	3	8.3	......	......	10.81	......	......
Solid and liquid, fresh.....	4	40.2	......	......	30 60	......	......
Solid, leached................	5	8.4	......	......	7.38	......	......
Solid and liquid, leached..	6	13.8	......	......	22.06	......	......
Nitrate of Soda.............	7	75.8	......	......	80.43	......	......
Nitrate of Soda.............	8	69.0	......	......	76.30	......	......
Sulfate of Ammonia........	17	50 3	......	......	68.84	......	......
Dried Blood..................	18	40.4	......	......	52.15	......	......
7 and 3 in......................	9	16.4	21.12	22.2	19.97	22.10	9.64
8 and 3 in......................	10	29.4	27.59	......	27.99	28.95	3.32
7 and 4 in......................	11	46.5	44.74	......	41.43	38.76	......
8 and 4 in......................	12	46.8	46.71	......	44.68	43 42	......
7 and 5 in......................	13	21.3	27.59	23.0	17.50	19.33	9.47
8 and 5 in......................	14	35.1	35.15	......	24 25	26.68	9.11
7 and 6 in......................	15	21.6	22.92	5.8	31.71	31.41	......
8 and 6 in......................	16	29.1	27.89	......	38.32	37.10	......
17 and 5 in....................	19	27.9	27.35	......	20.63	24.24	14.89
18 and 5 in....................	20	23.3	22.51	......	19.20	19.56	1.84

The difference between the percentage of nitrogen actually recovered and the percentage recoverable, calculated, represents the losses due to all causes; the difference is expressed in percentage in the last column. It appears that in 1900 the percentage recovery was greater in 9 out of 18 series, and of these 9, 6 were in series where the materials applied were used singly. This is particularly true of 6, 7, 8, 17 and 18. On the other hand, the percentage recovery is greater in 1899 in the series where the combinations of the different forms were used, that being especially noticeable in 10, 11, 12, 13, and 14. While it may be assumed that the greater availability of the nitrate, ammonia and dried blood was due in 1900 to a greater abundance of moisture, it is more difficult to determine the causes that were responsible for a slighter percentage of recovery on the series where

combinations were used. It is questionable in just how far the difference may be attributed to leaching in 1900, for the fact that the recovery from the double quantity of nitrate on series 8 was greater in that year than was the case in 1899, would indicate that but little, if any, of the nitrate nitrogen was washed beyond the reach of the plant roots. The differences in the amount of nitrogen applied may have had something to do with it; yet, even that is questionable, for the percentage recovery was slighter in 1900 on series 11 and 12, where more nitrogen was applied in 1899, as well as on series 13 and 14, where more nitrogen was applied in 1900. It is possible that the differences were due to denitrification, still for the present this is only a surmise.

As it is, the percentage of nitrogen recovered in 1900 exceeds the calculated recovery in four cases out of ten. They are series 11, with a recovery of 41.43 per cent., calculated 38.76; series 12, with a recovery of 44.68 per cent., calculated 43.42 per cent.; series 15, with a recovery of 31.71 per cent., calculated 31.41 per cent.; and series 16, with a recovery of 38.32 per cent., calculated 37.10 per cent. In series 15 and 16, where leached manure was used with nitrate, the percentage of nitrogen recovered differs to a greater extent from that of 1899. The figures for 1899 were 21.6 per cent. and 29.1 per cent., as against 31.71 per cent. and 38.23 per cent. in 1900. The losses varied from 1.84 per cent. on series 20, to 14.89 per cent. on series 19. In 1899 the maximum loss was 23 per cent. on series 13—the minimum loss, 5.8 per cent. on series 15.

That the season has much to do with the production and transformation of plant-food in the soil is brought out very graphically in the following columns, where the availabilities of the several nitrogenous substances are compared:

	Corn. 1898.	Oats. 1899.	Oats and Millet. 1899.	Oats. 1900.	Oats and Corn. 1900.
Nitrate of soda	100	100	100	100	100
Sulphate of ammonia	99.5	72.9	77.9	90.22	87.75
Dried blood	95.4	58.5	61.3	68.35	73.07
Solid manure, fresh	16 76	12.0	43.1	14.16	26.36
Solid manure, leached	37.87	12.1	46.4	9.67	21.99
Solid and liquid, fresh	49.66	58.2	88.4	40.10	51.46
Solid and liquid, leached	50.38	20.0	33.0	28.91	35.91

As was already pointed out in the report of 1900*, the superiority of the solid and liquid manure over the solid manure is brought out strikingly. Moreover, it appears from the later results that the solid manure, fresh, if anything, is superior to the solid manure, leached, which is contrary to what could be drawn from the results obtained in 1898. In 1899, the solid, fresh, and the solid, leached, showed the same rate of availability. In 1900, the solid, fresh, in the oat crop alone, and in the oats and corn taken together, shows a higher rate of availability. Similarly, in the case of the solid and liquid, fresh and leached, the availability was practically the same in 1898. It was higher for the fresh in 1899, and also in 1900.

Results of the Corn Experiment. Residual Effects.

The oats were harvested on July 6th. A few days later the soil in each cylinder was dug up and thoroughly stirred. One hundred kernels of corn were planted in each cylinder with the two-fold object of exhausting the nitrogen left over from the crop just harvested, and also of determining the influence of the residual nitrogen on plant growth. In using a considerable quantity of seed, it was intended to make the exhaustion more rapid and complete, and, at the same time, to insure greater uniformity of assimilation by eliminating to a great extent the influence of defective individual plants. By this means the average is made more truly representative.

* N. J. Station Report 1900, p. 102.

Result of the Corn Experiment.

Series.	Residual Nitrogen.	Dry Matter in Crop.	Nitrogen in Dry Matter.	Nitrogen in Crop.	Increase over Check Plot.	Per Cent. of Nitrogen Recovered.	Average Per Cent. of Residual Nitrogen Recovered.	Both Crops. Increase over Check Plot.	Both Crops. Per Cent. of Nitrogen Recovered.	Both Crops. Average.
	gms.	gms.	per ct.	gms.	gms.			gms.		
A	......	145.0	0.617	0.895	......	......	......	......	......	......
B	......	117.3	0.691	0.810	......	......	......	......	......	......
C	......	125.2	0.694	0.868	......	......	......	......	......	......
A	......	135.1	0.579	0.782	......	......	......	......	......	......
B	......	124.4	0.649	0.807	(0.794)	......	......	......	......	......
C	......	124.0	0.640	0.794	......	......	......	......	......	......
A	3.57	193.6	0.624	1.207	0.413	11.57	......	0.895	22.10	
B	3.48	175.9	0.605	1.064	0.270	7.76	10.02	0.839	20.72	19.78
C	3.79	201.7	0.596	1.201	0.407	10.74	......	0.669	16.52	
A	2.48	201.0	0.581	1.168	0.374	15.08	......	1.878	47.19	
B	2.90	178.9	0.645	1.158	0.359	12.38	11.75	1.434	36.03	38.61
C	2.90	159.4	0.640	1.020	0.226	7.79	......	1.301	32.61	
A	3.67	224.4	0.577	1.294	0.500	13.62	......	0.819	20.53	
B	3.78	178.9	0.589	1.055	0.261	6.90	9.86	0.473	11.85	16.50
C	3.64	169.8	0.662	1.124	0.330	9.07	......	0.683	17.12	
A	3.07	162.2	0.603	0.977	0.183	5.96	......	1.151	28.49	
B	3.12	155.9	0.627	0.978	0.184	5.90	6.25	1.099	27.20	26.94
C	3.25	139.8	0.729	1.018	0.224	6.89	......	1.015	25.12	
A	0.11	126.7	0.660	0.836	0.042	38.18	......	0.728	93.33	
B	0.21	103.9	0.660	0.685	0.109	......	......	0.459	58.85	72.22
C	0.15	98.0	0.685	0.671	0.123	......	......	0.503	64.49	
A	0.32	125.1	0.618	0.773	0.021	......	......	1.210	78.06	
B	0.40	133.0	0.680	0.838	0.044	11.00	......	1.196	77.16	75.03
C	0.38	105.7	0.674	0.712	0.082	......	......	1.083	69.87	
A	3.85	215.4	0.618	1.330	0.536	13.92	......	1.516	31.39	
B	3.86	189.6	0.601	1.139	0.345	8.95	9.91	1.314	27.20	27.89
C	3.89	158.5	0.670	1.061	0.267	6.86	......	1.211	25.07	
A	4.16	202.2	0.575	1.162	0.368	8.85	......	1.806	32.25	
B	3.76	237.6	0.573	1.361	0.567	15.08	10.80	2.405	42.95	35.66
C	4.17	189.3	0.605	1.147	0.353	8.47	......	1.779	31.77	
A	2.52	187.8	0.633	1.188	0.394	15.63	......	2.631	55.27	
B	3.11	185.1	0.627	1.160	0.366	11.77	11.56	2.075	42.33	48.14
C	2.73	166.0	0.598	0.993	0.199	7.29	......	2.229	46.83	
A	2.73	225.0	0.591	1.330	0.536	19.36	......	3.333	60.27	
B	3.20	183.6	0.645	1.184	0.390	12.19	12.92	2.716	49.11	51.62
C	3.24	170.4	0.598	1.019	0.225	6.94	......	2.515	45.48	
A	3.92	255.3	0.527	1.344	0.550	14.03	......	1.402	29.39	
B	3.98	182.4	0.578	1.052	0.258	6.48	11.42	1.047	21.95	26.90
C	3.91	226.3	0.589	1.332	0.538	13.76	......	1.401	29.37	
A	4.12	224.8	0.556	1.250	0.456	11.07	......	1.871	33.77	
B	4.21	195.6	0.608	1.190	0.396	9.41	9.03	1.727	31.17	31.07
C	4.25	174.3	0.617	1.075	0.281	6.61	......	1.566	28.27	
A	3.07	200.0	0.588	1.177	0.383	12.47	......	2.135	44.29	
B	3.35	185.9	0.606	1.127	0.333	9.94	10.66	1.805	37.45	38.95
C	3.46	172.8	0.652	1.125	0.331	9.57	......	1.692	35.10	
A	3.09	206.6	0.555	1.146	0.352	11.39	......	2.850	50.98	
B	3.47	189.7	0.580	1.099	0.305	8.79	8.95	2.425	43.38	43.80
C	3.77	160.5	0.641	1.046	0.252	6.68	......	2.070	37.03	
A	0.45	115.9	0.649	0.752	0.042	......	......	1.027	67.57	
B	0.49	131.8	0.621	0.819	0.025	5.10	......	1.050	69.08	65.84
C	0.47	92.7	0.728	0.674	0.120	......	......	0.925	60.86	
A	0.74	137.2	0.646	0.886	0.092	12.43	......	0.839	56.31	
B	0.66	120.6	0.670	0.808	0.014	2.12	5.48	0.847	56.85	54.83
C	0.74	120.5	0.671	0.808	0.014	1.89	......	0.765	51.34	
A	4.58	173.7	0.652	1.132	0.338	7.38	......	1.272	23.09	
B	4.22	174.1	0.654	1.139	0.345	8.18	8.08	1.637	29.71	27.02
C	4.33	174.6	0.670	1.170	0.376	8.68	......	1.557	28.26	
A	4.44	182.9	0.667	1.220	0.426	9.60	......	1.461	26.66	
B	4.48	174.9	0.677	1.184	0.390	8.71	9.02	1.388	25.33	26.48
C	4.36	170.7	0.689	1.175	0.381	8.74	......	1.504	27.45	

Amount of Residual Nitrogen and Proportion Recovered.

	Millet—1899.			Corn—1900.		
Series.	Taken out by the Oats.	Residual Nitrogen. Grams.	Average Per Cent. of Residual Nitrogen Recovered. Per cent.	Taken out by the Oats.	Residual Nitrogen. Grams.	Average Per Cent. of Residual Nitrogen Recovered. Per cent.
1	......	......	......	......	......	......
2	......	......	......	......	......	......
3	8.3	3.04	17.5	10.81	3.61	10.02
4	40.2	3.14	15.9	30.60	2.76	11.75
5	8.4	1.80	19.2	7.38	3.70	9.86
6	13.8	3.90	5.5	22.06	3.15	6.25
7	75.8	0.19	......	80.42	0.16	......
8	69.0	0.48	......	76 30	0.37	......
9	16.4	3.43	12 7	19.97	3.87	9.91
10	29.4	3.44	17.8	27.99	4 03	10.80
11	46.5	3.23	16.8	41.43	2.79	11.56
12	46 8	3.61	21.8	44.68	3.06	12.92
13	21.3	2.16	6.8	17.50	3.94	11.42
14	35.1	2.28	10.6	24.25	4.19	9.03
15	21.6	4.16	5.9	31.71	3.29	10.66
16	29.1	4.31	6.9	38 32	3.44	8.95
17	50.3	0.81	......	68 84	0.47	......
18	40.4	0.92	......	52.15	0.71	5.48
19	27.9	2.58	7.5	20.63	4 38	8.08
20	23.3	2.69	11.1	19.20	4.43	9.02
Average		2 56	12.6		2.91	9.71

The figures again bring out the facts already noted in 1899. In all cases where manure had been applied, the plants were enabled to secure a larger amount of nitrogen than those on the check plot. More than that, the series where solid manure alone was applied, yielded more nitrogen in the residual crop, as compared with the series on which solid and liquid manure was applied. On the other hand, there was no gain over the check plot from the nitrate of soda and sulfate of ammonia, in fact, there was even a slight loss. In the case of the dried blood, there was a small gain over the check plot. Hence it may be said here that there was no *residual* effect from the nitrate and the ammonia, and a very slight effect from the dried blood. Owing to a more uniform germination of the seed, the corn produced results also more uniform as compared with the millet of 1899. It will be observed that the yield of nitrogen on series 2 was

even slighter than that on series 1, differing in this respect from the millet. Also this crop shows a percentage of nitrogen higher than the average in the dry matter on all of the series where there was no residual effect, as well as on the first two series, where no nitrogen was applied. Of the residual nitrogen, proportionately less was recovered in 1900. There was on the average, 2.56 grams of residual nitrogen in each series in 1899, and 2.91 grams in 1900. Of that, there was recovered 12.6 per cent. in 1899, and 9.71 per cent. in 1900. The last figures represent the average per cent. recovery from fourteen series in 1899, and from fifteen series in 1900.

THE AVAILABILITY OF THE RESIDUAL NITROGEN IN THE SOLID AND IN THE SOLID AND LIQUID PORTIONS OF FRESH MANURE, AND ALSO OF LEACHED MANURES.

In 1899 there was 3.04 grams of residual nitrogen on series 3, and 3.14 grams on series 4, when the oats were harvested. In 1900, there was 3.61 grams of residual nitrogen on series 3, and 2.76 grams on series 4. Of that nitrogen, there was recovered by the millet 17.8 per cent. on series 3, and 15.9 per cent. on series 4 ; while the corn recovered 10.02 per cent. on series 3, and 11.75 per cent. on series 4. It appears that the recovery in 1899 was greater than that in 1900, and furthermore the solid manure does not make as good a showing in 1900, as compared with the solid and liquid manure. This is applicable to both the fresh and leached manure. Thus the recovery from the solid and liquid manure, fresh, was greater, relatively, than the recovery from the solid manure, which is contrary to the experiience of 1899. However, tables F and G show that the absolute amounts of nitrogen furnished by the solid manure to the residual crops are greater than those supplied by the solid and liquid portions. The same is true of the leached manures. The solid portion yielded in 1899, 1.398 grams of nitrogen, the solid and liquid portions yielded in 1899, 1.269 grams. The corresponding figures for 1900 are 1.158 grams for the solid, leached, and .991 grams for the solid and liquid, leached. In 5 and 6 the residual nitrogen was in 1899, 1.80 grams and 3.90 grams, respectively, and of that there was recovered 19.2 per cent. for 5, and 5.5 per cent. for 6. In 1900 the residual nitrogen amounted to 3.70 grams in 5, and 3.15 in 6, and of that there was yielded in the corn 9.86 per cent. for 5, and 6.25 per cent. for 6. As in the previous year the varying amounts of residual nitrogen rend-

ered the problem more complicated, for all that, it appears that th greater the proportionate amount of soluble nitrogen in the manu applied, the smaller the amount of nitrogen recovered in the residu crop. Of the manure applied in 1899, there was contained in th solid portion .073 per cent. of soluble nitrogen, and in the solid an liquid portion .220 per cent. of soluble nitrogen. The residual cro obtained from series 3, on the average, 1.582 grams of nitrogen an from series 4, on the average, 1.558 grams of nitrogen, notwithstand ing the fact that there was applied on 4, 5.25 grams of nitrogen, a against 3.32 grams on series 3. Similarly, in 1900, the solid portion fresh, contained .066 per cent. of soluble nitrogen, and the solid an liquid portion, fresh, .269 per cent. of soluble nitrogen. The residu crop obtained from 3, 1.157 grams of nitrogen and from series 4, 1.11 grams of nitrogen; the same relations hold true, even more markedly in the leached manures. The reason for the above is quite apparen if we consider that it is the soluble nitrogen in the manure that rapidly changed, and having once undergone the change it is lik nitrate, in that it is largely lost to the crop if not taken up within short time. The figures clearly indicate that there is no residu effect from the nitrate, and hence the more rapidly a given manu is nitrified, the smaller, everything else being equal, will be it residual effect. It should also be noted here that in the case of th solid, leached, the residual crop appropriated more nitrogen than th first crop. This is true of both the millet and the corn. Subtractin the amount of nitrogen obtained from the check plots, we find tha the oats in 1900 obtained from the solid manure, leached, .295 gram of nitrogen, while the corn following the oats obtained from the res due .364 grams of nitrogen. Similarly, the oats in 1899 obtaine from series 5, .165 grams of nitrogen, while the millet following th oats obtained .346 grams of nitrogen.

TABLE F.

rn of 1900—The Study of Residual Effects.

es.	Average Weight of Nitrogen in Crop. Grams.	Average Per Cent. of Nitrogen in Crop. Per cent.
....	.858	.667
....	.794	.629
....	1.157	.608
....	1.114	.622
....	1.158	.609
....	.991	.653
....	.731	.668
....	.774	.641
....	1.177	.629
....	1.223	.584
....	1.114	.619
....	1.178	.611
....	1 243	.565
....	1.172	.594
....	1.143	.615
....	1.097	.592
....	.748	.666
....	.834	.662
....	1.147	.659
....	1.193	.678

TABLE G.

let of 1899—The Study of Residual Effects.

es.	Average Weight of Nitrogen in Crop. Grams.	Average Per Cent. of Nitrogen in Crop. Per cent.
....	1.000	2.514
....	1.052	1.223
....	1.582	1.176
....	1.558	1.160
....	1.398	1.239
....	1.269	1.322
....	.878	1.304
....	.854	1.425
....	1.487	1.441
....	1.661	1.234
....	1.598	1.291
....	1.834	1.132
....	1.199	1.143
....	1.292	1.115
....	1.296	1.256
....	1.347	1.409
....	.948	1.301
....	.961	1.305
....	1.245	1.283
....	1.352	1.493

THE AVAILABILITY OF THE RESIDUAL NITROGEN IN THE FORM OF NITRATE, OF AMMONIA, AND OF ORGANIC MATTER IN DRIED BLOOD.

It was already noted that from the nitrate, both 5 and 10 grams, and from the ammonia no residual effect was obtained. The yield of nitrogen, on series 2, was .799 grams. On series 7, where 5 grams of nitrogen were applied, the yield was .731 grams.; and on series 8, with the double quantity of nitrate, the yield of nitrogen in the crop was .774. So that there was actually less nitrogen gathered by the residual crop from 7 and 8 than there was from the blank series. A similar observation was made in 1899, and the explanation seems to be that with the aid of the minerals and the nitrate, stronger plants are developed on 7 and 8 than there are on 2, and these because of their better developed root system are enabled to get more nitrogen out of the soil itself and thus leave it poorer. This view is supported by a comparison of the yields on series 1 and 2. It will be noticed that the residual corn crop obtained more nitrogen from series 1 than it did from series 2. Now, no nitrogen has been added to either for three years, but minerals were applied on series 2, and these enabled the crops to withdraw more nitrogen from the soil, as a study of the analytical data will show. In like manner, on series 17 there was no residual effect, and the nitrogen gathered by the corn was only .748 grams, less than that obtained from series 2. Above all things it seems clear that no residual effect need be expected from ammonium sulfate. And it should be remembered that the residual crops were planted within a few days after the oat crops were harvested. On series 18 there was a slight gain over series 2, indicating that there was at least a small residue of nitrogen left for the corn. In 1899 no such effect was observed on 18, and should further experience prove that there is some residual effect from dried blood it can by no means be very great. Hence, as in 1899, we are confronted by the fact that although but 52.15 per cent. of nitrogen was recovered from the amount applied as dried blood, but 68.84 per cent. from that applied as sulfate of ammonia, and but 76.30 per cent. from that applied as nitrate; no further benefit to succeeding crops need be expected from those particular applications. If anything, the availability of these three forms of nitrogen was slightly exaggerated, because of the greater amounts of nitrogen taken out of the soil with their co-operation, nitrogen that was credited to them.

THE EFFECT OF THE USE OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, FRESH AND LEACHED, ALONE, AND WITH NITROGEN IN THE FORM OF NITRATE, OF AMMONIA AND OF ORGANIC MATTER.

In the table submitted below are given the amounts of nitrogen applied, the percentage of the applied nitrogen recovered in the residual crop, the residual nitrogen after that crop, and the percentage of nitrogen obtained from the residue by the residual crop.

TABLE H.

No. of Series.	Total Nitrogen Applied. Grams.	Nitrogen Recovered. Per cent	Residual Nitrogen. Grams.	Nitrogen Recovered. Per cent.
3	4 05	8.96	3.61	10.02
4	3.98	8 04	2.76	11.75
5	3.99	9 12	3.70	9.86
6	4 04	4.83	3 15	6.25
7	0 78	......	0.16	......
8	1.55	.....	0.37	......
17	1.52	......	0.47	......
18	1.49	2.68	0.71	5.48
9	4 83	7.93	3 87	9.91
10	5.60	7.66	4.03	10.80
11	4.76	6.72	2 79	11.56
12	5.53	6 94	3 06	12.92
13	4.77	9.41	3.94	11.42
14	5.54	6 80	4.19	9.03
15	4 82	7.24	3.29	10.66
16	5.59	5.42	3.44	8.95
19	5.51	6.41	4.38	8.08
20	5.48	7.28	4.43	9 02

The relations pointed out in the last report largely hold true also this year. The recovery in the combinations does not differ much from the recovery in the manures alone, which might be expected since, as we have already found, the nitrate and ammonia show no residual effect, while the dried blood shows but a very slight residual effect. It should again be emphasized here, that the tabulated figures show less favorably for the manures used in combination than is actually the case, for as a matter of fact the recovery from the nitrate plots was less than from series 2, which was used as the standard of comparison. In 1899 the solid, leached, showed the

greatest variation in recovery, the figures being 19.2 per cent. for 5, and only 6.8 per cent. and 10.6 per cent., respectively, for 13 and 14. In 1900 the results are more uniform. The recovery for 5 is 9.86 per cent. of the residual nitrogen (table H), while the average recovery from 13, 14, 19 and 20, where 5 was used in combination with 7, 8, 17 and 18, is 9.37 per cent. Similarly the recovery from 3 is 10.02 per cent., and the average recovery from 9 and 10 is 10.35 per cent. The recovery from 4 is 11.75 per cent., and the average recovery from 11 and 12 is 12.24 per cent. In 6 the recovery was 6.25 per cent., while the average recovery in 15 and 16 was 9.80 per cent., showing a considerable increase for the two, an increase that was not quite as marked in 1899. The maximum residual recovery was 12.92 per cent. in series 12; the minimum residual recovery was 5.48 in series 18. In 1899, the maximum residual recovery was 21.8 per cent. in 12, and the minimum residual recovery 5.5 per cent. in 6.

THE AVAILABILITY OF THE NITROGEN IN THE DIFFERENT MATERIALS USED WHEN THE COMBINED RESULTS OF THE TWO CROPS, OATS AND CORN, ARE CONSIDERED.

Because of a more favorable season, the availability of the nitrate, ammonia and of the dried blood, was higher than it was in 1899. Not alone was there a greater quantity of nitrogen taken out of the check plots, but it also seems that on the nitrate, ammonia and dried blood plots there was a proportionately larger quantity taken out of the soil. This assumption is justified by the results obtained from the residual crops on the series named. It follows from this, that when the first crop is taken alone, the availability of the three forms mentioned is placed somewhat above its true value. On the other hand, the exhaustion of the humus on these series would modify the soil to such an extent as to influence the yields appreciably. It is for these reasons that the returns from the combinations cannot be expected to be almost exactly equal to the sum for the series where the materials are used singly. Aside from the slight discrepancies, however, the agreements are more than satisfactory.

From quick-acting materials immediate returns are expected and no residual effects are looked for. Hence, they are at a disadvantage when compared with slowly decaying organic materials through two or more crops. This was already pointed out in last year's report.

It was also noted then that on account of the smaller returns in the residual crop from 7, 8, 17 as compared with series 2, the percentage recovery of these materials is somewhat lowered, since the losses shown for these materials in the residual crop must be subtracted from the gains made in the oat crops. A more detailed discussion of the point in question was already presented in last year's report.* The following table shows the percentage recovery of nitrogen for all of the series when the two crops are used as the basis of calculation, as well as the calculated recovery on those series where the combination of materials was used.

	No. of Series.	Nitrogen Recovered. Per cent.	Calculated Recovery. Per cent.	Nitrogen not Recovered in the Combinations of Material. Per cent.
Solid manure, fresh	3	19.78	......	......
Solid and liquid, fresh	4	38.61	......	......
Solid, leached	5	16.50	......	......
Solid and liquid, leached	6	26.94	......	......
Nitrate of soda	7	72.22	......	......
Nitrate of soda	8	75 03	......	......
Sulfate of ammonia	17	65.84	......	......
Dried blood	18	54.83		......
7 and 3 in	9	27.89	28.24	1.24
8 and 3 in	10	35.66	35.07	......
7 and 4 in	11	48.14	44.14	......
8 and 4 in	12	51 62	48.84	......
7 and 5 in	13	26.90	25.60	......
8 and 5 in	14	31.07	32.87	5.48
7 and 6 in	15	38.95	34.25	......
8 and 6 in	16	43.80	40.27	......
17 and 5 in	19	27.02	30.11	10 26
18 and 5 in	20	26 48	26.92	1 63

The figures show that in six cases out of ten there was a gain on the combinations over the sum of the increase on the materials when they were used singly. Of the other four, 9 and 20 show but slight differences, and may be disregarded, on 14 and 19 the losses were 5.48 and 10.26 per cent. respectively. It is evident from the results, that there was no denitrification, and this confirms the experience of last year. The following table shows the percentage of availability of the nitrogen in the different substances, the percentage recovery of the nitrate nitrogen on series 8 being taken as 100.

* N. J. Station Report 1900, p. 108.

Oats—1900.

Nitrate of soda	100.
Sulfate of ammonia	90.22
Dried blood	68 35
Solid manure, fresh	14.16
Solid manure, leached	9.67
Solid and liquid, fresh	40.10
Solid and liquid, leached	28.91

Oats and Corn—1900.

Nitrate of soda	100
Sulfate of ammonia	87.75
Dried blood	73.07
Solid manure, fresh	26.36
Solid manure, leached	21.99
Solid and liquid, fresh	51 46
Solid and liquid, leached	35.91

It is quite apparent that in the residual effect considered, the avail ability of the manure, especially the solid manures, is increased ver considerably. At the same time the availability of the nitrate an of the ammonia is decreased, as was already pointed out, and there fore the relations of the different substances to one another ar changed very markedly. The reason for the apparent greater avail ability of the solid manure, fresh, of the solid and liquid, fresh, an of the solid manure, leached, in 1899, lies not so much in the greate recovery from those manures, as in the slighter recovery from th nitrate used as the standard of comparison.

Comparison of Yields on Series I. and II.

In series I., where no applications of manure were made, and i series II., where minerals only were applied, there was a limite amount of plant-food to start with. In the series of sandy soils, tha amount was still more limited, because the soil was made up of th same clay loam as in the other series, diluted by one-half its weigh of sand, containing no plant-food. Now, in series II. large amount of potash and phosphoric acid were added, so that the crops we enabled to exhaust the available nitrogen much sooner than in serie I., and for this reason the yields of nitrogen from series II. we greater than those from series I. However, as time advances th differences should be less and less marked ; for, according to Wagne the yield of plant-substance from any soil is governed by that plan

food constituent present in least quantities. In this particular case, it is the nitrogen which is present in series I. and II. in constantly diminishing quantities, and since there is a minimum amount of nitrogen absolutely necessary for the production of a given quantity of plant-substance, it becomes evident that no matter what the extent of the other plant-food constituents present, the yield of crop from the two plots cannot exceed a certain limit. The yields of dry matter and of the nitrogen contained in them are given below :

Series.		Corn—1898. Dry Matter in Crop. gms.	Nitrogen in Crop. gms.	Average Nitrogen gms.	Oats—1899. Dry Matter in Crop. gms.	Nitrogen in Crop. gms.	Average Nitrogen. gms.
I.	A	240.2	1.95	1.74	54.3	.805	.789
	B	208.0	1.47		49.7	.738	
	C	195.8	1.80		58.4	.825	
II.	A	289.6	1.79	1.87	56.7	.798	.831
	B	253.9	1.44		60.3	.817	
	C	329.8	2.38		61.5	.879	

Series.		Millet—1899. Dry Matter	Nitrogen	Average Nitrogen	Oats—1900. Dry Matter	Nitrogen	Average Nitrogen
I.	A	24.5	.830	1.00	81.8	1.143	1.108
	B	45.3	1.120		82.6	1.085	
	C	54.5	1.049		84.8	1.096	
II.	A	97.8	1.179	1.05	116.9	1.190	1.152
	B	84.0	.981		106.8	1.133	
	C	76.5	.993		107.1	1.133	

Series.		Corn—1900. Dry Matter	Nitrogen	Average Nitrogen
I.	A	145.0	.895	.857
	B	117.3	.810	
	C	125.2	.868	
II.	A	135.1	.782	.794
	B	124.4	.807	
	C	124.4	.794	

Differences in Series I. and II.

1898. gms.	1899. gms.	1899. gms.	1900. gms.	1900. gms.
.13	.042	.05	.044	—.063

In the first crop, that of 1898, there was a difference of .13 grams of nitrogen in series II. over that of series I. In 1899 there was a difference of .042 grams for the oats, and of .05 for the millet which followed the oats in the same cylinders. In 1900 there was a difference of .044 for the oats, but for the corn following the oats, there was more nitrogen taken out of series I. than there was out of series II. That might be accounted for by the fact that the abundance of potash and phosphoric acid allowed a more rapid exploitation of the

nitrogen in series II. However, that is only an assumption, furth work will show in how far it follows that also subsequent cro will get less nitrogen out of series II. than out of series I.

A comparison of the figures brings out another interesting fa namely, as to the amount of dry matter produced by a unit nitrogen. The results are given in the subjoined table.

Amount of Dry Matter Produced Per Unit of Nitrogen.

Series.		Corn—1898. Dry Matter in Crop. gms.	Nitro-gen in Crop. gms.	Dry Matter Per Unit of Nitro-gen. gms.	Oats—1899. Dry Matter in Crop. gms.	Nitro-gen in Crop. gms.	Dr Mat P Unit Nit ge gm
I.	A	249.2	1.95		54.3	.805	
	B	208.0	1.47	123.4	49.7	.738	6
	C	195.8	1.80		58.4	.825	
II.	A	289.6	1 79		56.7	.798	
	B	253.6	1.44	155.7	60 3	.817	7
	C	329.8	2.38		61.5	.879	
		Millet—1899.			**Oats—1900.**		
I.	A	24.5	.830		81.8	1.143	
	B	45.3	1.120	41.4	82.6	1.085	7
	C	54.5	1.049		84.8	1.096	
II.	A	97.8	1.179		116.9	1.190	
	B	84.0	.984	82.0	106.8	1.133	9
	C	76.5	.993		107.1	1 133	
		Corn—1900.					
I.	A	145.0	.895				
	B	117.3	.810	150.7			
	C	125.2	.868				
II.	A	135.1	.782				
	B	124.4	.807	163.3			
	C	124.0	.794				

It appears, then, that, thanks to a sufficient supply of potash a phosphoric acid, the small amount of nitrogen at the disposal of t crop could be exploited to a greater extent. It is because of th fact that so much more dry matter was produced on series II. against series I., although from the latter practically as much nit gen was taken out.

A REVIEW OF THE INVESTIGATIONS CONCERNING DENITRIFICATION.

Since the beginning of these experiments in the early summer of 1898, many contributions have been made toward the better understanding of the various problems of plant nutrition. Among these, the nitrogen question has been receiving the attention of many investigators, and it has been examined from the different standpoints of the soil chemist, the soil physicist and the soil bacteriologist. Much time and ingenuity have been devoted to the clearing up of that phase of the nitrogen question known as "dentrification," the destruction of the nitrates and the setting free of gaseous nitrogen. That deoxidation of combined nitrogen is liable to take place, and actually does take place in anaerobic fermentation has been known for years, but the question assumed more than a mere scientific interest since the emphatic declaration of Wagner[1] that applications of cow or horse manure to the soil are often not only unprofitable, but harmful, that, when applied together with the nitrates, they cause, by virtue of the micro-organisms contained in them, the destruction of the nitrates. More than that, the baneful effects do not stop here, for the nitrates as they are gradually formed from the organic matter of the soil are also attacked by the dentrifying bacteria, and their nitrogen set free. In a word, then, the animal manure applied is not only useless of itself, but is harmful because of its destructive effects on the oxidized nitrogen derived from other sources.

It is quite apparent that the interests involved are of great moment, that Wagner's theory, if it be borne out by practical experience, vitally concerns the man of science, the practical farmer and the world at large. And it was in the hope of contributing something to the knowledge of the subject that these experiments were planned. The scope of the work included the study of:

I. The composition of the solid and liquid portions of cow manure, fresh.

II. The composition of the solid and of the solid and liquid portions of cow manure, leached.

III. The availability of the nitrogen in the solid and in the solid and liquid portions of cow manure, fresh.

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[1] Wagner. Deutsche Land. Presse., Feb., 1895.

IV. The availability of the nitrogen in the solid and in the solid and liquid portions of cow manure, leached.

V. The relative availability of the nitrogen in the form of nitrate, of ammonia and of organic matter in dried blood.

VI. The effect of the use of the solid and of the solid and liquid portions of cow manure, fresh and leached, with nitrogen in the form of nitrate, of ammonia and of organic matter.

The results obtained are definite and clearly point in one direction, in so far as the question of denitrification is concerned, and are in accord with those of other investigators. The experimental data submitted below bring out this point forcibly.

As the work progressed and the accumulated material was studied, other questions presented themselves. They concern the movement of the plant-food in the soil and in the plant, the relation of the mineral salts to the organic matter, the influence of rainfall, the rapidity of nitrification, &c. While still following the main lines of research, as indicated, the other points have been examined in so far as was practicable, and deductions drawn where the experimental data at hand warranted it. Obviously, the many factors that determine the yield of crop are closely related to one another, and a true understanding of the subject can only come with a careful study of the soil from more than one standpoint. As a recent bulletin aptly expresses it,[2] "Our first object is to determine the *controlling* factor of fertility, * * * whether and when this factor is physical, depending upon the color, texture, or structure of the soil; climatological, depending upon temperature, sunshine and rainfall; chemical, depending upon the absolute chemical composition, or upon a definite minimum solubility of the soil's constituents," or, we might add, bacteriological, depending upon the activity of soil organisms.

That the latter is not the least important is attested by the numerous researches on their relation to the nitrogen question, both in its constructive and destructive phases. According to Stoklasa,[3] "the assimilation of the nitrogen of the air by bacteria forms one of the most important problems of modern biological research." On the one hand, we have the symbiotic life of the B. radicicola with the plants of the leguminous family resulting in the fixation of atmospheric nitrogen; on the other hand we have organisms like clostri-

[2] Bulletin No. 70, Maryland Agr. Expt. Sta., p. 64.

[3] Die Stickstoffassimilation durch die lebende Bacterienzelle. J. Stoklasa & E. Vitek, Centr. für Bact. und Paras, Vol. VII., (1901), No. 8, p. 257.

dium Pasterianum, which, as Winogradsky has shown, can assimilate atmospheric nitrogen independently, or Caron's Bacillus Ellenbachi, which, Stoklasa claims, can also assimilate atmospheric nitrogen. These, and others, probably, constantly work to preserve and increase our stock of combined nitrogen in the soil; they are the constructive agents. At the same time, there exist in the soil, and in decaying vegetable matter, numerous micro-organisms that have the power, under the proper conditions, to break up certain nitrogen compounds, and in this process much or all of the nitrogen is returned to the atmosphere, whence it originally came, in the gaseous state; these latter organisms are the destructive agents. It is their activities that concern the subject of our inquiry more directly, and a brief review of the more important work along these lines will help us to understand better the experimental data submitted below.

As far back as 1867, Froehde had observed[4] that the reduction of nitrates takes place, at times, when they are in contact with certain organic substances. There appeared to be a considerable number of the latter possessing such reducing properties. From that early observation, to our present knowledge, of the specific micro-organisms causing, under given conditions, the destruction of nitrates, the study of the subject, though gradual, was decidedly irregular. It was only within the last five or six years that a careful and systematic examination of the question enabled us to gain a more definite conception of the processes of denitrification. For all that, there is much that is yet obscure, and much that calls for further study. The latter is particularly true of the denitrification processes as they appear in practical agriculture; since, as has been pointed out repeatedly, the conclusions obtained from laboratory experiments are not always applicable to actual practice, creating, as they do, abnormal conditions not encountered in the field. As with nitrification, the earlier investigators attempted to explain denitrification by purely chemical reactions, and to the French chemists largely belongs the credit for being the first to point out to us the probable bacterial character of the denitrification processes. However, some years before that Schoenbein[5] had noticed that nitrates are reduced to nitrites by fungi, and that the presence of nitrites in drinking water might indicate that it contains micro-organisms. Dr. Angus Smith, in 1867, had also noticed[6] that a reduction of nitrates with the evaporation of free nitrogen takes place in the decomposition of sewage.

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[4] Jour. für pract. Chemie, 102, 1867, p. 46.
[5] Jour. für pract. Chemie, 105, 1868, p. 211.
[6] Manures and Manuring, Aikman, p. 177.

The work done since then, and leading up to the more detail recent studies, will be briefly reviewed here. Meusel[7] observed tl transformation of nitrates into nitrites in drinking water, and a tributed the formation of nitrites to bacteria. Chabrier states[8] th all soils contain nitrous acid, that in dry weather nitrates accum late at the surface, and that nitrites occur in larger quantity in tl lower layers of the soil. In another place[9] he finds that there is small loss of nitrogen (liberated as gaseous nitrogen) in nitrificatio This latter fact was also observed somewhat later by Boussingault and later by Pickard,[11] and subsequently by Godlewski.[12] Jea nel[13] found that when in contact with humus, dead leaves and stra nitrates are reduced to nitrites ; and Schloesing[14] showed that in large bottle, whose atmosphere was kept free from oxygen, potassiu nitrate was reduced to ammonia, and, also, some of the combin nitrogen was set free. Boname,[15] a year later, also came to the co clusion that nitrates are reduced in an atmosphere free from oxyge To Schloesing, also, belongs the credit of having established[16] tl fact that nitrogen is set free in the putrefactive decomposition urine and in the lactic fermentation of sugar in the presence of pota sium nitrate.

Pesci[17] noted that nitrates are reduced to nitrites when the actio is allowed to go on under water, and E. W. Davy[18] observed that a excess of animal matter in solution retards nitrification. Hüfner,[19] o the other hand, decided that no gaseous nitrogen is set free in tl decay of organic substances.

Deherain and Maquenne[20] had also observed the reduction nitrates. They attributed this action to anaerobic ferments, ar showed that the gases set free contained, besides carbon dioxide, al free nitrogen and nitrous oxide. About the same time Gayon ar

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[7] Annales de chim. et de physique, XXIII., (1871), p. 161.
[8] Compt. rend. 67, p. 1031.
[9] Compt. rend. 73, p. 1480.
[10] Compt rend. 76, (1873), p. 22.
[11] Jour.d agricult. practique II , 1884, p. 373.
[12] Cent. f. Bact. 1896, p. 458.
[13] Compt. rend 75 (1872), p 1244.
[14] Compt. rend. 77 (1873) pp. 203 and 353.
[15] Ann. Stat. Agron (Mauritius), 1896, p. 74, Abstr. in E. S. R. 1897, p. 731.
[16] Journal de pharmacie et de chimie, 4th. series, Vol. VIII., p. 213, 1868.
[17] Berichte chem. Gesels 8, 259.
[18] Chem. Soc. Jour. (1879), p. 429.
[19] Jour. f. pract. Chemie 1876, p. 292.
[20] Ann. Agron IX., p. 5 (1882).

reduction of nitrates in the soil. They describe nt" capable of reducing nitrates rapidly. In nitrogen is set free. They also found that the matter for their development, that part of the ransformed into ammonia, and, perhaps, also s of the organic substance. Heraeus,[22] too, had n of nitrates to nitrites and ammonia by bacteria, ed what he called a "ferment," rod-shaped, and capable of reducing nitrates.

d Dupetit[24] isolated two organisms, B. denitri- able of reducing nitrates with the evolution of Besides these, they encountered a number of duce nitrates to nitrites. According to the com- ive medium the nitrogen of the nitrates may be nixed with nitrous oxide. The oxygen of the l with the nitrogen of the nitrous oxide, unites e organic matter, giving carbon dioxide, which part forming bicarbonate of potassium (KNO_3 lture medium containing 10 grams of potassium ent on the addition of some soil. The authors position of nitrates by B. denitrificans is not a r a secondary phenomenon, but a "combustion by the nitric oxygen with the liberation of much ermentation that can take place only with the rence of several chemical reactions." Kellner that although losses of nitrogen occur in the organic matter, yet the losses are slight, even progressed for a long time. Ehrenberg,[26] in a xperiments, showed that "neither in the pres- ree oxygen; neither in solution nor in slightly nasses permeable to gases, is elementary nitrogen gency of micro-organisms." Tacke[27] reaches a nile Immendorf[28] states distinctly that according

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DV., pp. 644 and 1365.
Inf. vol. I., p. 193.
I., 1, p. 1228.
uction de nitrates par les infiiment petits, Station Agrono- y, 1886.
hemie, 1887, p. 95.
hemie, XI., 145.
Bd. 16 (1887), p. 937.
1, p. 316.

to his experiments the setting free of nitrogen from decaying organ
matter is not a purely chemical process, but it is effected with the a
of micro-organisms. It will be seen from this that, while there we
still adherents of the chemical theory in Germany, the belief w
beginning to prevail that the destruction of nitrates is due to bacteri
Two years later Tacke[29] admits that Berthelot was right when l
claimed that there are nitrogen fixing bacteria in the soil, and add
that there are also present in the soil organisms that set free nitrog
from its compounds.

Holdefleiss[30] was led to believe that even in yard manure co
stantly compacted by animals, and with the oxygen thus excluded t
nitrification processes take place to some extent. Hence the greate
loss through the formation of free nitrogen takes place in the manu
pile and not in the stable. By compacting the manure the nitrific
tion processes can be limited, and we must depend on mechanic
treatment to delay nitrification until the manure reaches the so
Of course, in preventing nitrification in the manure pile, the losses
free nitrogen, due to denitrification, are largely prevented.

Leme[31] found that the addition of large quantities of fresh manur
not only stops nitrification, but that there is at first a reduction
nitrates to nitrites, and of the latter to ammonia. Breal[32] announc
that many substances of organic origin, and especially straw, are t
carriers of denitrifying organisms. Obviously, the discovery is of fa
reaching importance. Since these organisms are carried to the manu
in the litter, and later are plowed in the soil with the manure, it b
comes interesting to determine to what extent denitrification tak
place, either in the manure pile or in the soil. In order that den
trification might take place it is essential that nitrates be present, a
we must assume that where no nitrates are applied as such, nitrific
tion must first take place that denitrification might follow. E. V
Davy,[33] Leme,[34] Pickard,[35] Lipman,[36] and others have shown th
large quantities of organic matter either retard or entirely stop nitri
cation, and for that reason the losses of nitrogen from fresh manu
due to the destruction of nitrates cannot be great. On the oth

[29] Landw. Jahsb. 18 (1889), p. 439.
[30] Holdefleiss, Der Stallmist (1889) Breslau.
[31] Naturwis. Rund. V (1890), p. 291.
[32] Ann. Agron. XVIII, p. 181.
[33] Chem. Soc. Jour. 35 (1879), p. 429.
[34] Natur Rund. V. (1890), p. 291.
[35] Compt. Rend. 114 (1892), p. 490.
[36] Master's Thesis, Cornell University, 1900.

hand, losses of nitrogen may take place in other ways, and there is much evidence that confirms this view.

Konig,[37] in his prize essay, stated that "the losses of nitrogen from manure due to the volatilization of ammonia appear to be slight," and he is inclined to think that the greater losses are due to the liberation of elementary nitrogen. Immendorf,[38] on the other hand, comes to the conclusion that the chief cause of the loss of combined nitrogen in manure with the usual treatment, may be attributed to the volatilization of ammonia, and finds that the formation of elementary nitrogen influences these losses only to a limited extent. Burri, Herfeldt and Stutzer[39] carried out some experimental work to decide as to the causes that lead to losses of nitrogen in decaying organic substances, especially in dung and liquid. They are led to believe that where denitrification takes place it is preceded by nitrification. Hence they conclude that "in the decay of nitrogenous organic substances there is no setting free of elementary nitrogen as long as the activity of the nitrifying organisms in the decaying substance is suppressed." On the other hand, they believe that a considerable evolution of free nitrogen may take place when nitrates are added to dung or liquid manure, or when opportunity is given to the nitrifying organisms for active development. The splitting off of free nitrogen may be caused by the reduction of nitrates, or by the action of nitrous acid or ammonia or amines. The authors point out later that denitrification is rather due to living organisms than to purely chemical reactions, as Ehrenberg[40] assumes; nitrification, they think, may run to completion without the evolution of free nitrogen, such evolution is more likely to take place in the decaying mass when the supply of oxygen is limited. In such cases the oxygen of the nitrates is utilized and the nitrogen is set free.[41] Since in the fresh manure scarcely any nitrification takes place, the denitrification cannot be considerable. In another communication the same authors suggest that the object of a rational method of conservation should not only consist in preventing the volatilization of ammonia, but also in controlling the course of fermentation so as to favor the development of bacteria that transform organic nitrogen into ammonium carbonate.

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[37] Wie Kann der Landwirt den Stickstoffvorrat in seiner Wirtshaft erhalten und vermehren, p. 84.

[38] Jour. für Landw, 42 (1894), p. 78.

[39] Jour. für Landw. 42 (1894) p. 329.

[40] Ehrenberg, Zeitschr. f. physiol. Chemie, XI., 470.

[41] Ehrenberg, l. c. 445.

Following the example of Gayon and Dupetit, Burri and Stutzer were led to attempt the isolation of denitrifying organisms. The work appeared the more desirable in view of Breal's[42] discovery, already alluded to, and of a communication from Wagner that nitrate of soda yielded inadequate returns when used together with horse manure. In communicating[43] the results of their experiments, they call attention to the fact that there are but a limited number of organisms capable of oxidizing nitrogen, while of those possessing the power of reduction (deoxidation) the number is great. Of these, however, the greater part can only reduce nitrates to nitrites, and the bacteria capable of reducing nitrates to ammonia, or of setting nitrogen free, are not very numerous. Of the work not already referred to, they mention that of Deherain and Maquenne,[44] who observed that in the gases set free in denitrification there is contained, besides nitrogen, also carbon dioxide and hydrogen. Also, the work of Giltay and Aberson[45] is mentioned. The latter describe a bacillus capable of destroying large quantities of nitrate with the evolution of free nitrogen. Burri and Stutzer finally succeeded in isolating two organisms capable of reducing nitrates completely, which they named B. denitrificans I. and B. denitrificans II. Their conclusions[46] may be summed up as follows: "When oxygen is completely excluded, B. denitificans I., together with B. coli, does not cause the evolution of free nitrogen in culture solutions containing nitrate, but most of the nitrate nitrogen is reduced to nitrite nitrogen. With a limited supply of oxygen, B. denitrificans I. can develop to such an extent as to be able, together with B. coli, to cause the fermentation of nitrate with the evolution of free nitrogen. When once started, the fermentation takes its usual rapid course. B. denitrificans I. uses in this case some of the oxygen derived from the nitrates. With a liberal supply of air, B. denitrificans I., together with B. coli, causes the destruction of nitrates in the normal way. With the complete exclusion of air, B. denitrificans II. causes the destruction of nitrates in the normal manner. With a liberal supply of air, the ability of B. denitrificans II. to cause the fermentation of nitrates is diminished or entirely suppressed."

[42] Compt. rend. CXIV., p 681.
[43] Centr. f Bact., 1895, pp. 257, 350, 392, 422.
[44] Compt. rend. XCV, pp. 691, 732, 854.
[45] Extrait des Archives Neerlandaises, XXV, p. 341-361.
[46] Centr. f. Bact. 1895, p. 431.

It follows from the above that the destruction of nitrates may be favored both by the exclusion of the air from the manure pile or by the admission of air to it. In the one case the activity of B. denitrificans II. is favored, in the other that of B. denitrificans I. The authors suggest the destruction of the bacteria before the manure is put on the field. According to Marchal[47] the behavior of B. mycoides in nutritive solutions containing nitrates is rather striking. When inoculated into a solution containing glucose and about 2 gr. of KNO_3 per liter, nitrites and ammonia could be detected in a few days, and in fifteen days ammonia alone. It appears, thus, that the same organisms may exert either an oxidizing or reducing action. Both processes are intimately connected with the respiration of the organism. In one case albuminoids are normally oxidized with the aid of atmospheric oxygen, in the other, the intramolecular respiration leads to a utilization of the nitrate oxygen to oxidize the sugar.

Attempts to isolate denitrifying organisms were also made by Schirokikh.[48] He was successful in obtaining a pure culture of an organism capable of destroying nitrates. He describes it as a bacillus with rounded ends, having no vacuoles, and one and one-half to two times as long as it is wide. It is motile, though not as markedly as, for instance B. pyocyaneus.

A further study of the denitrifying organisms isolated by Burri and Stutzer[49] is contributed by Stutzer and Maul.[50] The authors finally come to the conclusion that B. denitrificans I., together with B. coli, destroy nitrates in a flask that is merely stoppered, but when air is passed through the the liquid in the flask, denitrification is not as active. Also, Ampola and Garino[51] isolated a denitrifying organism which they named B. denitrificans agilis. They found that it is capable of dertroying nitrates rapidly. In examining the gases involved they found them to consist of nitrogen and carbon dioxide, the latter being present to the extent of 15 per cent. In searching for practical means to diminish denitrification in manure, the same authors[52] decided that peat prevents denitrification by virtue of the acidity it imparts to the manure, but when the manure again becomes alkaline denitrification again takes place.

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[47] Agricult. Science, VIII., 1894, p. 574.
[48] Centr. fur Bact. 1896, p. 204.
[49] Centr. f. Bact. 1895, pp. 257, 350, 392, 422
[50] Centr. f. Bact. 1896, p. 473.
[51] Centr. f. Bact. 1896, p. 670.
[52] Centr. f. Bact. 1897, p. 309.

S. A. Sewerin[53] isolated 32 different organisms from horse man and studied 29 of these. In one case strong foaming was noti and it was found that there were at least two species capable of ducing nitrates completely. Further study showed that there also 9 species capable of reducing nitrates to nitrites, 18 species b indifferent. By diluting the nitrate solution to 0.1 per cent more showed complete reduction, and still further dilution to per cent. showed 4 more organisms capable of complete reductior all 8 species. It appears, also, that proportionately larger quant of KNO_3 than of $NaNo_3$ are reduced in a given time, and 0.6 cent. of $NaNo_3$ appears to be the limit of reduction. The au also finds that the stirring of the soil and greater æration ten diminish denitrification.

His studies of B. denitrificans II. led Hjalmar Jensen[54] to bel that it can be grown as anaerobe. He finds a certain relatior tween the nitrate destroyed and the carbon compounds used. denitrification takes place without a source of carbon being plied.[55]

P. P. Deherain[56] confirms Breal's claim that there are denitrif bacteria on straw, and Wagner's that these organisms are foun animal excreta. He finds that they occur in cultivated soils; tha nitrogen set free by them is accompanied by carbon dioxide, and o by nitrous oxide; that the amount of nitrogen used by the organi to build their tissues is comparatively small; they utilize only oxygen of the nitrate, and more readily exercise their reducing ac in a closed space. When ordinary quantities of manure are appl nitrification, rather than denitrification, takes place. It is ha necessary to treat the manure with sulphuric acid to destroy denitrifying organisms.

It has been noted above, that of denitrifying, or nitrate-destro organisms, a large number are known at the present day, and t is no doubt that when a more thorough study is made of the sul many more will be added to the list. Thus Stoklasa[57] enumer the following bacteria as capable of causing the fermentatior nitrates in the presence of organic acids, or of pentoses and hexo Bac. humosus, Bac. fluorescens lique-faciens, Bac. Pyocyaneus,

[53] Centr. f. Bact. 1897, p. 504.
[54] Centr. f. Bact. 1897, p. 554.
[55] Centr. f. Bact. 1897, p. 622.
[56] Ann. Agron. 23, p. 49.
[57] Centr. für Bact. und Paras, VII (1901), No. 8, p. 260.

denitrificans, Bac. coli commune, Bac. Stutzeri, and many others that have been studied less carefully. As it is to be expected, these organisms do not possess the power of denitrification in an equal degree. The author just referred to, says that the analysis of the gas produced by B. Hartlebii showed 70 to 96 per cent. of nitrate nitrogen set free, the rest having been transformed into organic nitrogen. Furthermore, the destructive fermentation of nitrates depends to a great extent on the character of the organic acids in the nutritive medium, some being much better adapted than others to furnish the necessary energy for the breaking down of the nitrates. Stoklasa also claims that most of the denitrifying bacteria can cause no reduction of nitrates in media where chemically pure d-lavulose and d-galactose are present. The nitrate, he believes, is first reduced to ammonia and that is oxidized with the liberation of free nitrogen. However, not all of the ammonia is thus oxidized, for a part of its nitrogen is transformed into the organic form, a fact that was long ago noticed by Schloesing.[58] An interesting study of several manure bacteria and of the products of their activity is contributed by T. Severin.[59] Of the several organisms that he isolated from manure, some seem to differ materially from the others. Thus B. pyocyaneus, and what he calls B. N2 will not produce Co_2 and NH_3 from solid manure alone, but will attack it when it is mixed with liquid manure. On the other hand, one organism which the author designates as No. 1 seems to be more active in the absence of urine. This fact is significant in that it introduces a new factor in the study of the relative value of solid and of solid and liquid manure in plant nutrition. It is evident that in judging of the availability of the two forms we must bear in mind that with the solid manure alone, some of the organisms failing to find some soluble form of nitrogen (like that furnished by the liquid manure), do not multiply very fast, and hence the decomposition of the solid manure proceeds but slowly. Moreover, with a sufficient amount of soluble nitrogen to start with, these organisms multiply rapidly and finally attack the solid manure more vigorously. From this, it follows that, thanks to the presence of the liquid manure, the solid portion is decomposed more readily and its nitrogen becomes available sooner and in proportionately larger quantities than would be the case if it were left to itself. Therefore, when the solid

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[58] Compt. Rend. CIX (1889), p. 423.

[59] Centr. für Bact und Paras Vol. VII. (1901), No. 11, p. 369.

and the solid and liquid portions are used together more nitrogen becomes available to the crop in a given time than would be the case when the two are used singly. But there is still another factor that should not be overlooked. It was already pointed out above, and namely, that at least one organism is known that attacks solid manure more readily in the absence of liquid manure. Assuming that the latter organism were to find conditions favorable for its development, it would decompose more solid manure in a given time, and in the absence of the liquid portion, than it would in a mixture of the two, and from this it follows that as far as this particular organism is concerned, more nitrogen would become available to the crop in a given time where the two are used separately. Under what conditions one organism will develop to the exclusion of the others, and what the most favorable conditions are in either case, is not definitely known. Severin found that after one organism is allowed to multiply in a sample of manure for a length of time, and the manure then re-inoculated with another organism, or with a fresh culture of the same organism, their activity is very limited and soon ceases altogether. The sterilization of the manure and re-inoculation seem to help matters a little, but even then the fermentation is not as active as in a fresh sample, and soon it diminishes rapidly until it is scarcely perceptible. These facts indicate that in the course of bacterial activity certain products are formed that are injurious to the bacteria themselves, and that sterilization does not destroy these products to any great extent. The author also observes that two organisms, when inoculated into the sterile sample of manure, produce more ammonia and carbon dioxide in a given time, in other words, decompose more organic matter than they would when acting singly. Whatever conclusions may be drawn from the above facts, it is clear that there are many factors to reckon with in the study of animal manures, and that our knowledge of some of these factors is decidedly scanty.

Some of the accumulated facts bearing on the conditions most suitable for the growth and development of the denitrifying bacteria we owe to Stutzer. In a recent article[60] he claims that denitrification in nutritive solutions is not favored by glucose, but is promoted by the presence of salts of organic acids, like potassium lactate or potassium nitrate. The reason for this he attributes to the fact that glucose is not as suitable for furnishing the molecular energy required

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[60] Neue Untersuchungen über die Wirkung der salpeterzerstörenden Bacterien in Nahrlösungen, A. Stutzer, Centr. f. Bact. VII. (1901), No. 3, p 81.

for the breaking down of the nitrates as are the salts of organic acids. He tried four different organisms, and found that they possess the power of denitrification in a different degree. Their action on the different meat extracts in the market is also variable. Stutzer reports, for instance, that B. Hartlebii was the only organism that could destroy nitrates in a medium containing Liebig's meat extract. "Why is it," he asks, "that B. nitrovous, B. agilis and B. Stutzeri could find the necessary energy for the destruction of nitrates in a solution of potassium lactate, and not in a solution of glucose?" "Is the difference due to chemical constitution of the compounds in question, or is the ionization of the molecules the important factor?" It has been noticed that some nutritive materials serve better for the purpose of denitrification when they are first inoculated with certain non-denitrifying bacteria, sterilized after a certain length of time, and re-inoculated with the denitrifying organisms. Of these non-denitrifying organisms, B. subtilis, B. prodigiosus, B. lactis aerogenes and B. mycoides, modified the nutritive solutions so as to make them better adapted for the denitrifying bacteria, while B. megatherium seemed to be indifferent in this respect.

Turning to the more practical side of the denitrification question, we find that much thought has been given to it. Some years ago the experimental data at hand were so contradictory, and the points to be cleared up so numerous, that Pfeiffer was led to say: "There is scarcely another field of research in agricultural chemistry in which we encounter contradictions as numerous, and as fully unexplained." In order to clear up these contradictions, and to throw more light on the doubtful results, the German Agricultural Association called for a united effort on the part of the German Experiment Stations, offering, at the same time, to place the necessary means at their disposal. The call was answered and the work undertaken by the Experimental Stations of Augsburg, Darmstadt, Jena and Rostock, and, later on, by the Bonn and Gottingen Stations.[61] The investigation was to answer two general questions:

1. How are the great losses of nitrogen that take place in the decay of organic substances to be explained? "To what extent is the nitrogen liberated in the elementary state, and to what extent as ammonia, and how does the liberation of the first take place?

"2. What means do we possess of checking these losses, and how does the material thus employed act?"

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[61] Die Landwistsh. Vers. Stat. 48 (1896), p. 189.

The publication of the results was to be delayed until the existi uncertainty were cleared up. Since such was far from being the ca in 1896, it was decided to publish the results already received that time, for they contain much that is valuable, and are in ma respects conclusive. In accordance with this, there appeared the Landwirt-schaftlichen Versuchs-Stationen[62] the reports of B. Dietzel-Augsburg, of Th. Pfeiffer, E. Franke, C. Götze and H. Th mann-Jena, and of J. Aeby, R. Dorsch, Dr. Matz and P. Wagn Darmstadt. The combined reports make a very valuable contrib tion to the subject of denitrification, and will well repay a care study to all who are interested in the nitrogen question. In t place we can only review the general conclusions reached by the d ferent investigators.

Dietzel[63] found that no loss of nitrogen takes place in mixtures solid excreta and litter, or of urine and litter, provided that there no access of air. With the admission of air, losses do take pla and these are diminished by conservation materials. The producti of ammonia from solid manure alone is but slight, while the nitro of the liquid manure was almost entirely converted into ammo in the presence of conservation materials. The experiments Street[64] are in accord with Dietzel's results, for Street also find large increase in ammonia nitrogen in the presence of conservat materials.

The experiments of Pfeiffer, Franke, Götze and Thurmann more extensive.[65] They make note of Ehrenberg's careful exp ments[66] where he finds that no elementary nitrogen is set free fr decaying organic matter, except when nitrates are present wit limited supply of oxygen. They also point out that their results in agreement with the observations of Konig and others,[67] who st that "the losses of nitrogen from manure due to the volatilizatio ammonia are but slight, and that the losses of nitrogen in its elem tary form are of great extent." The authors state that they m their statement with a certain reserve in view of Immendorff's[68] cl that: "The chief cause for the loss of combined nitrogen fr

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[62] Land. Vers. Stat. 48 (1896).
[63] Land. Vers. Stat. 48 (1896), p. 177.
[64] Rep N. J. Expt. Stat., p. 94.
[65] Landw. Vers. Stat. 48 (1896), p. 189.
[66] Zeitschr. für physiol. Chemie, XI., p. 471.
[67] König, Stickstoffvorrat, p. 84.
[68] Jour. für Landw. 1894, p. 78.

ually treated, is due to the volatilization of am-
' the formation of elementary nitrogen plays but
n these losses." This claim they regard as some-
The current belief that nitrification takes place in
he nitrates formed (are) diffused downward and
the denitrifying organisms, they find not to be in
the facts observed, for they found that in some
pears from decaying masses even when there is a
air. The amount of nitrates found in manure is
ere is a possibility, they think, that elementary
iberated without the intermediate formation of
trogen could be formed directly in the oxidation
their experiments there were greater losses of
very case where there was a more liberal supply
er in these oxidation processes nitric acid is first
act with ammonia or amines causes the liberation
ther the ammonia is oxidized directly, cannot be

experiments of Pfeiffer, Franke, Götze and Thur-
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es of 32 to 34°, as against ordinary room tempera-
rogen did not increase much.
conditions nitrogen can be set free from its com-
entary form entirely. This was the case in most
, and the loss in this way amounted to as much
the entire amount originally present.
nonia, even on the addition of burnt lime, were
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ogen in its elementary form can take place in two
cation ; (b) oxidation of the ammonia. In our
iments the losses most probably took place as

9. Denitrification can take place with free access of air.

10. The action for a short time of 2 per cent. of burnt lime, on horse manure, apparently destroyed its denitrifying power; 3 per cent. of calcium carbonate, or 0.5 per cent. of sulphuric acid, seemed to be ineffective in this respect.

In the vegetation experiments, the action for 24 hours of 3 per cent. of burnt lime, and of 5 per cent. of marl on fresh cow manure, seemed to limit its denitrifying power.

11. The oxidation of ammonia, with the liberation of free nitrogen, is apparently due to micro-organisms.

12. The oxidation of ammonia is stopped by the addition of acid phosphate, provided there is enough of the latter present to neutralize all of the ammonia. Smaller quantities of acid phosphate have not, under the conditions of the experiment, limited the losses of free nitrogen in accordance with their ammonia-binding power.

13. The addition of burnt lime or of calcium carbonate to fermenting manure, at room temperature, stopped the liberation of elementary nitrogen almost entirely; most probably by killing the denitrifying bacteria.

14. The most favorable results obtained by the application of the different lime preparations as regards the limiting of denitrification, and of the oxidation of ammonia, lead to the following[69] conclusions: (a) The favorable action of lime is usually ascribed to its promoting nitrification. It is possible that its favorable action is partly due to the role it plays in stopping denitfrication. (b) The layering of manure with burnt lime or marl would limit the liberation of nitrogen, while covering the surface of the manure pile with soil would stop the loss of the volatilized ammonia.

15. The ammoniacal fermentation was not diminished even on the the addition of larger quantities of lime or acid phosphate, in fact, it increased in most cases. The addition of 1 per cent. of sulphuric acid decreased it but slightly.

The experiments of Aeby, Dorsh, Matz and Wagner, are described by the latter in his usual luminous style. The vegetation experiments were carried out in cylindrical pots, the different series containing 7 Kg., 18.5 Kg., 3.4 Kg., and 6 Kg. of soil. In every case enough mineral plant food was added to furnish a maximum amount. The general conclusions reached by the authors are as follows:

1. The relative availability of stable-manure nitrogen is considerably smaller than that of ammonia, nitrate and green plant-substance.

[69] Land. Vers. Stat. 48 (1896), pp. 247-360.

2. The nitrogen contained in solid animal excreta and in straw acts very slowly; by far the greatest portion of it is transformed into humus derived from organic substance and changes very gradually into ammonia and nitric acid.

3. The nitrogen contained in the liquid manure changes very rapidly, at ordinary room temperature in 48 hours, into ammonia. The addition of solid manure and of straw hastens considerably the ammoniacal fermentation.

4. Because of its rapid action and its relative availability, the liquid manure nitrogen may be considered equal to ammonia nitrogen.

5. When a rapidly growing crop is planted immediately after a heavy application of fresh solid manure a diminished yield may result.

6. The diminution in yield after an application of solid manure is due to the liberation of elementary nitrogen, brought about by the manure, and may be observed where active nitrogen (solid nitrogen, liquid manure nitrogen, green manure nitrogen, ammonia nitrogen, and nitrate nitrogen) is at the disposal of the plants.

7. The liberation of elementary nitrogen brought about by solid manure can be traced to denitrifying bacteria, which occur in solid animal excreta, especially in those of the horse, in great number.

8. Not alone fresh excreta, but also stable manure, possesses denitrifying properties.

9. About 100 grams of horse manure mixed with 1 liter of water and 3 grams of sodium nitrate, and exposed to room-temperature, caused, in 8 to 14 days, the liberation of all of the nitrate nitrogen in the elementary form.

10. The liberation of gaseous nitrogen, at least very slowly, takes place when a humus-containing field or garden soil acts on a nitrate solution.

11. Nitrogen is set free, at least very slowly, when cereal straw is in contact with a nitrate solution.

12. The nitrate destroying power of humus-containing soil, and of cereal straw is very much increased when soil and straw together are placed in contact with a nitrate solution.

13. The nitrate-destroying power of solid excreta is very considerably increased on the addition of straw.

14. According to theory, there should be 100 parts of liquid-mnaure nitrogen to every 100 parts of solid-manure nitrogen in stable manure. Practically, however, there are only 25 to 35 parts of liquid-manure

nitrogen to every 100 parts of solid-manure and straw nitrogen not more than 10 parts of urine nitrogen.

The reason for this is to be sought in the following consider (a) In many stables the liquid manure does not find its way manure heap in its entire quantity, for a part of it flows into (b) A part of the liquid manure nitrogen is lost by the volati of ammonia. (c) A part of the liquid-manure nitrogen is elementary nitrogen, the loss being caused by bacteria.

15. In the conservation of manure, the object is to find wa means through which : (a) The ammoniacal fermentation in n or (b) the volatilization of ammonia from urine and manure, the activity of the denitrifying organisms may be prevented.

16. The formation of ammonia in a mixture of solid excr straw is so gradual that for practical purposes it need not be ered in the conservation of manure. Solid excreta and straw be considered in the conservation of manure only in so far influence the decomposition processes of the liquid-manure n and its transformation.

17. When a mixture of solid excreta and straw are placed in 80 to 100 cm. thick, the changes that take place are sligh when it is thus exposed for 12 months, provided that the well compacted, that is, the access of air largely excluded. the other hand, the mass is loosened so that the air has free ac it, decomposition and transformation processes come into pl humification of the manure takes place with a rise of tempe and the loss in organic substance may amount to as much as cent. The ordinary conservation materials (gypsum, sup phate, superphosphate gypsum, kainit), as well as burnt lime used in ordinary quantities do not appear to exert an appr influence on the humification process.

18. As the humification of the manure advances, its destroying power diminishes in proportion, yet it does not dis entirely, even in far-reaching humification. While it is p that the more favorable action of well-rotted, dark-colored m observed in practical experience, as over against that of fresh m is due in the main to the diminished nitrate-destroying power by decay, yet an artificially-hastened humification offers no p method for the conservation of manure.

19. Additions of customary quantities of the conservatio stances named above, in the customary way, exert no influe the diminution of the nitrate-destroying power that takes place

course of humification. Only on prolonged exposure and far-reaching humification of the manure could it be shown that gypsum, superphosphate gypsum and kainit, modified the nitrate-destroying power of the manure; on the other hand, the addition of burnt lime produced a diminution of the nitrate-destroying power.

20. By the proper treatment of manure with carbon bisulphide, it is possible to reduce its nitrate-destroying power to a minimum. Nevertheless, the amount of carbon bisulphide required, and the length of time it should act, make it unavailable as a conservation agent.

21. Free sulphuric acid on the one hand, and copper sulphate on the other, are substances by means of which the activity of the manure bacteria can be energetically combatted, and it remains to be proved whether these substances can be successfully used in the practical conservation of manure.

It will be noticed that the Jena and Darmstadt Stations have reached similar conclusions in regard to certain phenomena. The experiments of both indicate that with a limited supply of air in the manure the losses of elementary nitrogen and of organic substance are not very extensive. Conversely, the greater the access of air, the greater the loss of nitrogen, in some cases reaching to as much as 40 to 50 per cent. Both find that the ordinary conservation materials, when applied in the usual quantities, do not stop entirely the loss of nitrogen, that the losses of ammonia from manure are comparatively slight, that the setting free of elementary nitrogen, caused by stable manure, is due to micro-organisms in that manure, and that burnt lime is effective in stopping denitrification to a great extent. It might be added here that the results obtained at the Darmstadt Station[70] indicate that "solid excreta and straw lose their nitrogen so very slowly that no conservation materials are needed. It is only the nitrogen of urine that requires conservation."

It may be stated here that Pagnoul[71] had found that horse manure, especially in the presence of starch, tends to cause the disappearance of nitrates, but at 30° with a sufficient supply of oxygen and water, there is no loss of free nitrogen, but the conversion of nitrate into organic combinations. It should be added here, perhaps, that the same investigator had some years earlier[72] declared that ordinary quantities of horse manure do not cause denitrification in the soil.

[70] Forshungen über den relativen Düngerwert, etc., des Stallmiststickstoffs, Land. Ver. Stat. 48 (1896), p. 302.

[71] Ann. Agron. II., 1898, p. 97.

[72] Ann. Agron. 21 (1895), p. 497.

Also Ragoyski found[73] that lime largely prevents the loss of nitrogen. He used 6 kg. lots of manure made up of 61.7 per cent. of cow dung, 26.7 per cent. of urine, and 11.6 per cent. of straw, and exposed in glass cylinders. In the manure that was untreated, there was a loss (in 56 days) of 36.6 per cent. of the nitrogen originally present. The treatment with 1 per cent. of a mixture of sulphuric and hydro-fluosilicic acids reduced the loss to 4.7 per cent.; where lime and soil were used as a covering there was an actual gain in nitrogen in one case, and in another case the loss was reduced to 7 per cent. In the manure that was treated, he finds a gain in albuminoid nitrogen. The treatment with the 1 per cent. of acid mixture showed a gain in albuminoid nitrogen of 26.6 per cent., the treatment with lime and soil gave a gain of 33 to 38.5 per cent., and there was a gain of 41.2 per cent. where the soil was mixed with the manure. When further tested by vegetation experiments, the author found that the nitrogen thus formed was not assimilable to the mustard crop. It is very likely that the increase in albuminoid nitrogen was due to the activity of bacteria, for also Street[74] and others have found this to be the case; but as to the availability of the organic nitrogen thus formed, there is a considerable difference of opinion. Nobbe and Hiltner[75] state definitely that the organic nitrogen produced by soil bacteria is not available, at least not immediately available, to the growing crop.

Pfeiffer, Franke, Lemmermann, and Schilbach[76] studied the availability of the nitrogen in different nitrogenous materials in both pot and field experiments. The substances used were nitrate of soda, sulphate of ammonia, ground horn, dried blood, meat and bone, and barnyard manure, both treated and untreated. Their experimental results may be stated briefly as follows:

1. Horn meal, dried blood and stable manure show a better rate of nitrogen availability in a three year cylinder experiment than is shown by the similar investigations of Wagner—

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[73] Ann. Agron. 25 (1899), pp. 244-248.

[74] N. J. Expt. Stat. Rep. 1900, p. 87.

[75] Land Vers. Stat. 45 (1895), p. 159.

[76] Die Wirkung des organischen Stickstoffs, speciell des Stallmiststickstoffs bei der Düngung. Land. Vers. Stat. 51 (1899), p. 249.

Availability of Nitrogen in (N. in $NaNo_3$ = 100).

	According to Pfeiffer, etc.		According to Wagner.
Horn Meal	83 – 87 per cent.		63 per cent.
Dried Blood	85 "		69 "
Stable Manure, 1	46		
" " 2	56	49 "	32 "
" " 3	45		

2. The residual effect of these substances is a considerable one, and our experiments were so planned as to bring out this fact. The difference in the character of the soil used may have contributed to the differences obtained.

3. Two experimental series on field plots with manure, one which averaged for the three years in cylinders an availability of 46, led to the values 92 and 93 ($NaNo_3 = 100$) in the same period.

4. A better aeration of the soil leads in cylinders to a better exploitation of the manure nitrogen.

5. In the field plots the aeration must be better than in the cylinders, because of the circulation of water and the faster drying of the upper surface. The decomposition of the barnyard manure is, therefore, hastened, bringing about a better exploitation of the nitrogen.

6. The residual effect of the barnyard manure was apparent on plots containing a light, sandy soil in the second crop of the second year; but was no longer so in the third year. On the heavy Rothamsted soil, the after effect of the manure nitrogen could be seen distinctly after twenty-three years. These differences can be explained by the varying aeration, causing a more or less rapid decomposition of the manure. Hence, the different results obtained by us as compared with those of Wagner, especially as to the much better exploitation of manure nitrogen may be accounted for in this way.

For these and other reasons, *general* conclusions cannot be drawn from our results.

8. Since the manure nitrogen on the field plots showed almost as high an availability as the nitrate of soda nitrogen, it follows that notwithstanding an application of 600 D. centners per hectar, there was no denitrification to any appreciable extent.

9. It is impossible to decide, with certainty, as to the extent of the denitrification processes in the cylinders. It is likely that on account of the more limited aeration greater quantities of nitrogen were set

free, which would account for the slighter availability of the nitrogen We consider ourselves justified in thinking that there was not sufficient denitrification in the manure used to account for the smal availability of the manure nitrogen.

It would not be out of place here to examine a certain statemen of the authors that had a direct bearing on facts brought out in ou own experimental work. They attempt to account for the hig nitrogen content of plants grown on a soil poor in nitrogen.[77] Quoting Maerker's explanation[78] "that on a soil very poor in nitroge the plants starving for want of nitrogen do not pass their period o infancy; on account of their lack of nitrogen they are not able t form sufficient amounts of carbohydrates, and these result in ab normal plants, which die before they mature, and, therefore, are ric in nitrogen, while containing but a small amount of dry matter." The authors criticise this statement, and point out that there mus have been some other controlling factor, for with a plentiful suppl of the other plant-food constituents there should result a mass o plant-food substance of normal composition. A comparison of serie 1 and 2, in our experiments, will show that they are right in thi respect.

In an article entitled[79] "The Cause and Significance of the De composition of Nitrates in the Soil," Krüger and Schneidewind repo the results of their experiments. The work was undertaken in orde to solve the following problems: (*a*) Does the loosening of the soil caused by applications of manure, have anything to do with th diminution in yield? (*b*) Is it caused by the addition of organism that destroy nitrates? Or (*c*) is it caused by the addition of sub stances which favor the development of the nitrate-destroying organ isms, and thereby favor denitrification?

The investigation included both plot and field experiments, 6 kilo of soil being used in the former. They find that there was denitrifi cation in the pots, there being in every case a smaller yield over th nitrate alone when, together with the latter, fresh manure is used, an that with varying quantities of nitrates. However, as the amount of nitrate increased, the proportionate loss became smaller until i reached a certain limit, when it became practically constant. Th loosening effect on the soil is not responsible, they conclude, for th

[77] Land. Vers. Stat. 51 (1899), p. 258.

[78] Jahrbuch der Versuch Station, Halle II., 1896, p. 59.

[79] Ursache und Bedertung der Salpeterzerstörung in Boden, Land. Jahrb. 28, (1899 p. 217.

decrease in yield. To determine the other points with certainty, the manure was sterilized. Its application did not show much change for the better, and leads to the assumption that the denitrifying effects of manure are not due to the bacteria added by it to the soil, but rather to the substances in the manure favorable for the growth and development of these organisms. This belief was strengthened by the fact that where both manure and soil were sterilized there was no destruction of nitrates. It appears, further, that the addition of pentosans produces an active fermentation in nitrate solutions, that crude fiber does not cause as violent a fermentation, but that in the end the losses are about the same. Denitrification was caused by the addition of straw ; its action being the more intense the finer the state of division. Peat seems to differ in this respect from straw and shavings, for it does not cause denitrification. Proportionately high amounts of moisture seem to favor denitrification ; smaller amounts seem to be indifferent in this respect, even to the extent of 20 per cent. Nor does the rapidity of evaporation influence denitrification one way or another. An attempt was also made to determine whether the thickness of planting is a factor. The following amounts of nitrogen were taken out of the soil :

By 100 plants	.942	grams.
" 50 "	1.197	"
" 25 "	1.247	"

It would appear that where there were fewer plants, the root systems of each was better developed and, in consequence, better use was made of the plant-food in the soil. In their laboratory experiments, where flasks without soil were used, the denitrification processes were extensive, and it was noted, as was the experience of Street and Ragoyski, that in every case (but one) there was a gain of organic nitrogen. The formation of ammonia, Kruger and Schneidewind found, was but slight ; and they also note that in the destruction of nitrates, small quantities of ordinary bicarbonate and of sodium carbonate were formed. Where leguminous crops are grown there is no diminution in yield on the addition of straw or manure, and it appears that conditions which are favorable to nitrification are not necessarily unfavorable to denitrification. The authors express the belief that while the denitrification processes in the field are not as extensive as they are in the cylinders, yet even in field operations the denitrification processes are of considerable significance. The decomposition of nitrates in the field is not usually noticable, because

the nitrification processes here are more intense than they are in the cylinders, and hence, denitrification is less marked. Denitrification is also masked on the addition to the field of barnyard manure, because there is more soluble nitrogen added by the latter to the soil than is destroyed by the denitrifying bacteria. "A direct conclusion as to the extent of denitrification in practice can only be obtained by determining the action of liquid manure, or of nitrate for itself, on the one hand, and on the other hand the action of either when used together with solid excreta and straw." The authors state here that they intend to carry out such a series of experiments. We might point out here that our experimental work can give adequate information in this regard, as can be ascertained by consulting the data submitted below.

Pfeiffer and Lemmermann[80] do not agree with Krüger and Schneidewind in their claim that denitrification caused by manure is due to the organic matter it adds to the soil, rather than to the bacteria contained in it. The former state distinctly "that the increase of organic substance as well as that of denitrifying bacteria unfavorably influence the exploitation of the store of nitrogen." "Hence," they further add, "stable manure in so far as it gives rise to denitrification phenomena in the soil, does so not alone in virtue of its organic matter, but also as a carrier of bacteria." The experiments on which this claim is based were carried out very carefully, the soil being analysed before and after every experiment, to determine the gain or loss of nitrogen in the soil, and thus secure a direct check on the final balance. In some cases, however, the experimental error was too great to allow a definite conclusion. With 29 Kilos of soil, they believed to have conditions more nearly like those in the field, for with smaller amounts of soil the variations in temperature, moisture, etc., produced differences great enough to make the results inapplicable to actual practice.

Maerker had pointed out[81] that in the course of sterilization of manure, certain substances are formed that are injurious to plant life. It follows, if this be true, that a comparison in vegetation experiments of sterilized and unsterilized manure would not bring out the actual relations. To avoid this difficulty, Pfeiffer and Lemmermann sterilized both lots, and then inoculated one of them with a pure culture of B. dentrificans II., given to them by Dr. Künnemann. They find that there is an increase in the soil nitrogen of all the cylinders

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[80] Denitrification und Stalmistwirkung, Land. Vers. Stat, 54 (1900), p. 395.

[81] Jahr. Halle, II, 1896, p. 65.

on which no nitrogen had been applied, and are inclined to ascribe the cause of it to nitrogen-fixing bacteria. This view is confirmed by the experience of Aeby,[82] of Schneidewind,[83] and Richter.[84] The latter sums up his conclusions as follows: "(1). The several unsterilized vessels to which no nitrogen had been added show an increase in nitrogen. The gain is slight in the first crop, but increases later.

"(2). In all cases where nitrogen is applied, there is a loss of soil nitrogen. Hence, the increase of nitrogen in the soil takes place only when the latter is poor in assimilable nitrogen."

Pfeiffer and Lemmermann also find that there was no residual effect for the second crop on the cylinders where sodium nitrate alone was used, but where it was used with manure there was a residual effect. They attempt to account for the fact by assuming that in the presence of the manure bacteria a part of the nitrogen was converted into organic nitrogen, and the latter was utilized by the second crop. It was already pointed out above that Nobbe and Hiltner found such organic nitrogen to become available but slowly. The general conclusions are stated by the authors in the following paragraphs:

1. The unfavorable exploitation of the nitrogen store in the soil can be caused both by an increase of organic substance (source of energy), as well as of denitrifying bacteria.

2. In so far as manuring with stable manure, solid excreta, etc., at all, leads to denitrification in the soil, the manurial substance produces such an effect not alone through the organic matter it contains, but also as a carrier of bacteria.

3. The hypothesis of Gerlach that only such manure can act injuriously on the accompanying application of nitrate, as will act injuriously by itself, for otherwise, the amount of energy is used up in destroying the nitrates formed from that manure, does not agree with the facts observed. Gerlach's own experiments, and the experiments reported here, do not justify such conclusions.

4. The injurious effects of the first factor mentioned under 1, as they were shown in the first vegetation period in the cylinder experiments, were not apparent in the second crop.

5. The increase in organic substance by the application of a solution of potassium citrate, as well as the addition of a pure culture of denitrifying organisms, caused the evolution of elementary nitrogen.

6. The escape of elementary nitrogen, due to the application of

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[82] Landw Ver. Stat. 46 (1895), p. 409.

[83] Jour. für Landw. 45 (1897), p. 185.

[84] Land. Vers. Stat. 51 (1899), p. 221.

manure, is of a minor importance as compared with the other facto leading to the unsatisfactory exploitation of the manure nitrogen.

7. The utilization of nitrate of soda on a light, sandy soil is n affected either by cow or horse manure, applied up to the rate of 80 d. centner per hectar.

8. Since the same cattle manure showed different results on fie plots and cylinders, we would point here again that the results o tained from pot experiments are not always directly applicable practicable crop-growing.

9. The variable action of the nitrogen in the different manur cannot be accounted for by their varying content of ammonia, ami and digestible albuminoid-nitrogen, as shown by analysis.

10. The assumption that denitrification, that is, the liberation elementary nitrogen, offers a full explanation of the varying actio of the different manures, is excluded. The content in nitrogen-fr organic substance, especially in pentosans (xylose), does not seem, i our experiments, to have any definite relation to the observed nitr gen action.

11. There is a difference in the rate of decomposition of the di ferent manurial substances used by us, and in this we are inclined find the main reason for the varying action of manure nitrogen i general.

12. In loosely-packed manure, the transformation of the nitroge compounds into a form available to plants can be entirely suppresse even under the most favorable decomposition that leads to an exte sive decrease of the nitrogen-free organic substance. Neither an monia nor elementary nitrogen are liberated, and even the splittin off of amides from the albuminoids takes place to a limited exten and is concealed by the development of molds and other organism

13. We suspect that the phenomena mentioned under 11 and 1 are to be referred to the injurious action in the manure of proteolyt ferments; however, we must carry out further experimental work prove this point.

14. The residual effect of manure nitrogen, which is at times ve considerable, is again brought out.

15. When nitrate is applied together with manure, a part of th nitrogen of the former may be fixed, and may lead to an increase availability, or show a residual effect in the following crop.

The authors further cite instances where the decrease o not be attributed to denitrification. One is t

wind,[85] who applied 9 grams of nitrate nitrogen and 300 grams of straw, and found after the crop was harvested that there were still 3.3965 grams of nitrate nitrogen in the soil, notwithstanding the fact that the yield of nitrogen in this case was reduced by the straw from 3.5968 grams to 3.0634 grams. And, another instance from Krüger and Schneidewind,[86] where the yield of nitrogen was similiarly reduced from 4.873 grams to 4.498 grams, and yet there were still left in the soil 0.923 grams of nitrate nitrogen. In view of these and other facts cited, the authors believe that it is the organic substance itself, apart from any bacterial activity, that is often responsible for a diminished yield, at least in experimental work, where large quantities are used. Pfeiffer and Lemmermann are also inclined to think that since a part of the nitrate nitrogen is changed into the organic form, and is later utilized by the plant, it is manifestly unjust to decide on its relative availability from short vegetation experiments. Finally, they conclude that there are several factors responsible for the so-called denitrification process. There are at least three such factors, and namely:

1. Direct injury to the growing plants by larger quantities of organic substance.
2. Fixation of soluble nitrogen by the increased activity of different organisms.
3. Denitrification proper.

It is still to be learned which one of these factors plays the most important part economically, and how we are to modify and influence such activity.

From his more recent experiments[87] Rogoyski concludes that there is a denitrification of nitrates in the presence of large amounts of manure, the nitrogen being set free in the elementary state, while a part of it is transformed into organic combinations. Similar changes occur when soil containing large quantities of manure or straw is mixed with urine, or a solution of ammonia salts. The nitrogen thus fixed appears to be readily nitrifiable. When quantities used in practice were applied no denitrification took place, and the urine was nitrified. On the other hand, denitrification did take place when excessive quantities were applied.

[85] Jour. für Landw. 1897, p. 184.
[86] Landw. Jahrb. 1899, p. 221.
[87] Ann. Agron. 26 (1900), pp. 121-140.

The work of Wood[88] indicates that there was considerable denitrification when manure at the rate of 10 to 20 tons per acre was applied, together with nitrate. While there was some denitrification where well-rotted manure was used, the effects are more striking in the case of fresh manure. Thus nitrate alone gave an increase of 9½ bushels of grain per acre, while nitrate together with fresh manure gave practically no increase.

The above represents a brief review of most of the research work on denitrification and the changes in manures. The fact that great losses of nitrogen take place when excessive amounts of manure are applied, and that, conversely, no denitrification, or very little denitrification, takes place when ordinary quantities are applied; taken together with the experiments of Pfeiffer and Lemmermann, to prove that much of the reduction in yield usually attributed to denitrification is really due to the injurious effect of large amounts of organic matter, indicate that there is a phase of the subject that needs very careful investigation.

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[88] Bd. Agr. (London), Rept. Agr. Educat. and Research, 1899-1900, pp. 124, 125.

REPORT OF THE ASSISTANT IN SOIL CHEMISTRY AND BACTERIOLOGY.

SOIL CHEMISTRY AND BACTERIOLOGY.

Since the first of July of the present year, the provision has been made for the chemical and bacteriological study of soils. The general scope of the work, as planned, is the investigation of the movements of plant-food in the soil, and the part of bacteria in the formation, change or destruction of such plant-food. Obviously, the field is extensive, with work enough for many investigators. What the details of the present investigation shall be, must be determined by the work itself. In the course of its development the attempt will be made to answer, in so far as it is possible, the questions raised.

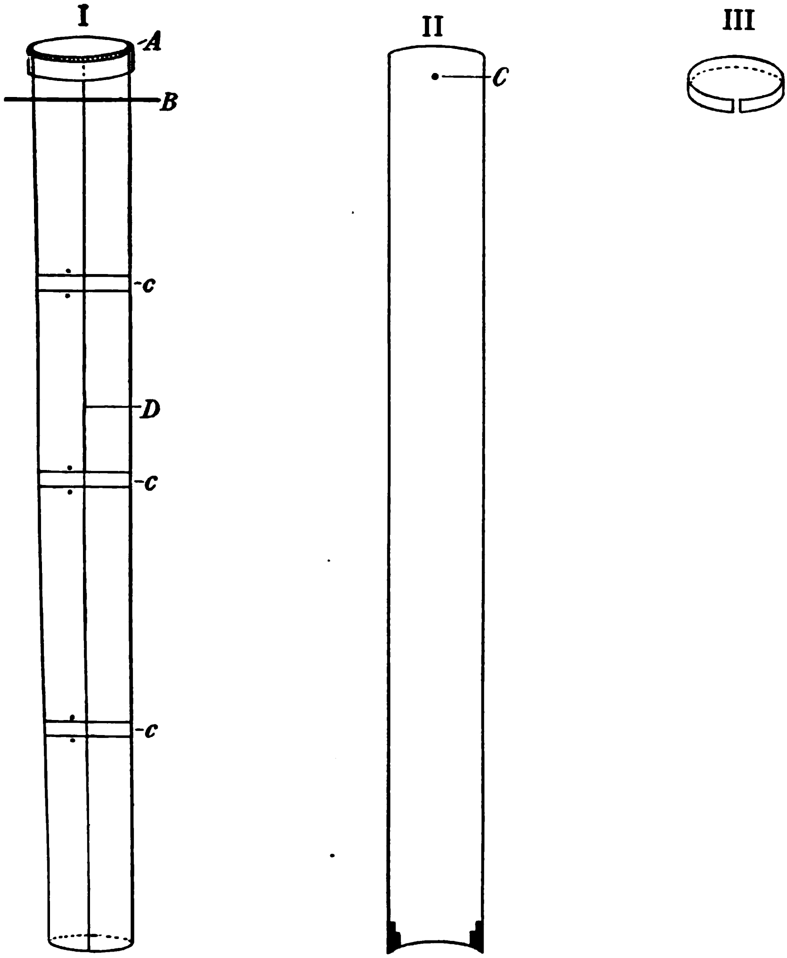
The first problem encountered in the preliminary work was that of securing representative soil samples. These are required both for analytical study and for preservation as museum specimens. The former is to include the field samples, as well as the soils of the cylinder experiments, reported in this volume. It became necessary, therefore, to design two distinct sampling tubes, each for a specific purpose. After some experimenting, two tubes were finally made that are eminently satisfactory for the purposes designated. The first of these is a brass tube one inch in internal diameter and three and one-half feet long. Its upper end is provided with a brass cap, and its lower end has soldered into it a steel ring, which is so constructed that it enables the core to slide up easily. The tube is cut in two along its entire length, the two halves being held in place by rings which are kept from sliding up or down, while the tube is in use, by two stops, one on each side of the ring. The rings are also divided so as to enable them to move past the stops when necessary, and may be compressed to fit more tightly around the tube. There is a circular hole through the tube, just a little below the cap, through which a steel rod is passed, and it serves to facilitate the boring of the tube into the soil. It should also be added, here, that the tube is graduated into inches. To secure a sample, the steel rod is passed through the head of the tube, and the latter pressed down-

ward until the desired depth is reached. The tube is then withdrawn, the cap and rings removed, and the tube being placed horizontally, one-half is taken off, exposing the core. If desired, any portion of the core representing certain depths, as indicated by the graduation, can be removed and retained for analysis. Such an arrangement makes possible the study of the plant-food in the different layers of the soil. The core taken out by this tube is small, but while it does not remove large quantities of soil from the limited amount in the cylinders, it yet furnishes enough material for the work in question.

The other sampling tube is constructed on the same principle. It is made of steel and provided with a steel cap. It is two and one-half feet long, divided like the other into two halves, which are held together by brass rings, and is two inches in internal diameter. This tube has been found very useful in the collection of soil and subsoil samples, both for analytical work and for museum specimens. In the latter case, the cores are transferred in their natural position into glass tubes of the proper dimensions, and, after being sealed and labeled, are ready for exhibition.

A preliminary survey has been made of the soils of South Jersey. The purpose in view was the study of the different soils in so far as they are typical for the growth of any particular crop. At the same time attention has been given to the geological derivation of the different soils, with the intention to determine, ultimately, the changes produced by cultivation, and the features common to the soils of any particular geological area. Thirty-six samples of soils and subsoils have been collected and prepared for analysis. At the same time they were subjected to a partial mechanical analysis, and the results thus far obtained, while they are of some significance, will be withheld from publication until more complete data are secured. The samples thus far secured range from the heavy clay soils of the marl beds to the sands and yellow gravels of the Post-Tertiary, and it is hoped that their study will yield some interesting results.

The microchemical study of soils solutions was begun. It opens a very promising field for future investigation, and may help to understand more clearly the changes that take place in the soil. The exact nature of the salts in aqueous soil solutions as they are influenced by the derivation of the soil itself, by its treatment and climatic conditions will, perhaps, be better understood by the application of such methods.



SOIL SAMPLING TUBE.

DIAGRAM I.—*a*, Steel cap; *b*, Steel rod passing through tube; *c*, Rings to hold the two halves together; *d*, line showing where the two halves are joined together.

DIAGRAM II.—Represents one-half of the sampling tube; *a*, Cutting edge; *b*, place where the steel rod passes through.

DIAGRAM III.—Shows one of the brass rings used to hold the tube together.

REPORT OF THE ASSISTANT IN HORTICULTURE.

REPORT OF THE ASSISTANT IN HORTICULTURE.

The work of the year has been a continuation of the various experiments outlined in previous reports, the detail of which requires, with each year, increasing attention. Fair crops have been obtained from most all the fruits and vegetables in the experimental plots. The permanent plots remain as usual, excepting that in plot 1 of the peaches, the second tree of Reeve's Favorite variety—natural fruit—was replaced. The variety Wager was also discarded, and one tree each of the new varieties, Carmen and Greensboro, planted in its place. To the list of novelties, a seedling of the Early Harvest blackberry has been added.

The rainfall records have been made as usual, and in Table 1 is given the daily and monthly precipitation for the year ending October 31st, together with the normal rainfall for this section. Table 2 contains the monthly and yearly records since January 1st, 1896, with the monthly and yearly normal.

The records show the year to have been a variable one as regards rainfall. Two months, February and June, had less than one inch, .76 and .81 inches, respectively, of rainfall, while April, July and August had nearly or quite double the normal. The lowest previous rainfall in the time covered by our records was 1.13 inches in June of 1898, and 1.41 inches in April of 1896. Up to the first of March, the first four months of the fiscal year, the rainfall was 2.74 inches below the normal, and for the year it is 2.26 above the normal.

TABLE 1.

Showing Daily and Monthly Precipitation in Inches at the College Farm for the Year Ending October 31st, 1901.

DATE.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
1	T	...	...	...	...	...	0.10	...	...	...	0.
2	0.12	...	...	...	0.07	...	T	...	0.48	...	0.
3	0.25	...	...	...	...	1.25	0.44	0.26	0.16	...	0.
4	...	1.35	...	0.57	...	0.13	...	...	0.08	0.29	...
5	...	0.13	...	...	0.23	0.03	...	...	0.19	...	...
6	...	...	...	...	...	*	...	...	0.69	0.29	...
7	...	...	T	...	...	1.10	...	0.47	3.40	1.92	...
8	0.65	...	...	...	...	...	...	...	0.04	...	...
9	0.40	T	...	0.17	0.19	...	0.05	...	0.16	...	...
10	...	...	0.32	...	0.02	...	1.05	...	...	...	...
11	...	T	0.51	...	2.49	...	0.50	...	0.13	0.06	0.
12	...	...	0.87	...	...	...	0.21	...	0.94	0.50	0.
13	...	...	...	...	...	...	0.10	...	0.09	0.10	0.
14	...	...	...	...	...	...	...	...	0.76	...	...
15	...	...	...	...	0.14	0.33	T	0.06	T	...	...
16	...	...	...	...	0.03	0.14	...	...	...	0.31	0.
17	...	...	0.02	...	...	...	...	...	...	...	0.
18	...	...	0.03	0.02	0.01	0.01	0.49	...	0.10	1.01	0.
19	...	...	T	...	...	...	...	...	...	0.35	0.
20	0.05	...	...	...	0.01	0.85	...	...	...	...	0.
21	0.07	...	...	...	1.34	2.35	...	...	...	1.10	...
22	...	0.03	0.01	T	...	0.11	...	...	...	...	...
23	...	0.01	...	...	...	0.03	0.12	0.02	0.09	T	...
24	0.14	0.02	...	...	0.13	0.65	...	...	...	2.97	...
25	0.74	...	0.11	...	T	0.39	0.62	...	...	...	...
26	1.85	...	...	...	0.37	0.02	0.21	...	0.20	...	...
27	...	...	...	...	0.16	...	0.59	...	...	...	...
28	...	0.09	...	...	...	...	0.06	...	0.02	...	...
29	...	...	...	...	...	...	0.36	...	0.91	...	0.
30	...	...	0.12	...	...	...	0.05	...	0.55	...	...
31	...	0.69	0.02	...	...	...	0.06	...	0.13	...	...
Total, 1901	4.27	2.32	2.01	0.76	5.19	7.39	5.01	0.81	9.12	8.90	1.
Normal rainfall	3.93	3.55	3.32	3.64	3.79	3.68	4.02	3.30	4.92	4.93	3.

* Included in that for the next day.

TABLE 2.

Showing Monthly Precipitation in Inches Since January 1st, 1896.

	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Yearly total.
Total, 1896	....	....	1.68	5.55	5.92	1.41	3.70	4.98	4.37	2.42	4.81	1.62	*36 71
Total, 1897	2.95	1.59	2.39	2.77	2.47	3.47	6.45	2.50	12.84	3.81	2.10	1.59	44.93
Total, 1898	4.52	5.09	3.92	3.49	3.09	4.17	7.56	1.18	3.91	6.44	1.46	5.80	50.83
Total, 1899	7.14	3.16	4.88	5.37	6.68	1.50	2.04	3.54	6.82	3.45	7.80	2.96	51.79
Total, 1900	4.11	2.06	4.35	5.30	3.40	2.38	5.58	2.64	6.94	2.24	3.30	3.53	45.88
Total, 1901	4.27	2.32	2.01	0.76	5.19	7.39	5.01	0.81	9.12	8.90	1.86	1.99	49.63
Normal	3.74	3.66	3.82	3.64	3.77	3.68	4.02	3.80	4.92	4.98	3.94	3.45	47.87

*Ten months only.

The Permanent Experiment Plots.

In order that the results may be better understood, the general plan of small fruit experiments is here repeated.

In each case, currants and gooseberries excepted, six varieties or six rows, 160 feet long and set in one block, are duplicated, giving 12 rows, of which rows 1 and 7, 2 and 8, etc., are of the same variety. Rows 7 to 12, inclusive, are irrigated as occasion demands, nothing being applied on rows 1 to 6. Lengthwise each block is divided into four equal plots 40 feet long. These unirrigated are numbered 1 to 4, those irrigated 5 to 8. Plots 1 and 5, 2 and 6, etc., are treated identically, except that plots 5 to 8 are irrigated. The plan for currants and gooseberries is the same, except that there are only four varieties with six plots, 25 feet instead of 40 feet in length.

Table 3 shows the fertilizers, amounts and times of application to be applied to the various plots. This plan has been carefully adhered to the past season. The irrigated plots received water during the month of June, the amount applied is noted in each case.

TABLE 3.

Showing Fertilizers, Amounts and Time Applied to the Different Plots, Asparagus and Small Fruits.

KIND OF FRUIT OR VEGETABLE.	Plots 1 and 5.	Plots 2 and 6.	Plots 3 and 7.	Plots 4 and 8.
Asparagus......	20 ts.* yard manure applied in fall.	500 lbs complete† applied in spring.	500 lbs. complete applied in spring; 300 lbs. bone and potash‡ applied in fall.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs. nitrate soda applied when cutting ended.
Blackberries ..	20 ts. yard manure applied in fall.	500 lbs. complete applied in spring.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs. nitrate soda applied after blossoming.
Raspberries	20 ts. yard manure applied in fall.	500 lbs. complete applied in spring.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall.	500 lbs complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs. nitrate soda applied after blossoming.
Strawberries...	500 lbs. complete applied in spring.	500 lbs. complete applied in spring; 150 lbs. nitrate soda applied after blossoming.	500 lbs. B., P. and A. P.§ applied in spring; 150 lbs. nitrate soda applied after blossoming.	500 lbs. B., P. and A. P. applied in spring.
	Plots 1 and 4.	Plots 2 and 5.	Plots 3 and 6.	
Currants....	20 ts. yard manure applied in fall.	500 lbs. B., P. and A. P. applied in fall.	500 lbs. B., P. and A. P. applied in fall; 150 lbs. nitrate soda applied after blossoming.	
Gooseberries...	20 ts. yard manure applied in fall.	500 lbs. B., P. and A. P. applied in fall.	500 lbs. B., P. and A. P. applied in fall; 150 lbs. nitrate soda applied after blossoming.	

This general arrangement of plots, fertilizers, etc., allows a study of—

a. The effect of irrigation.

b. The relative effect of fertilizers with and without irrigation.

1. Upon early yield.
2. Upon total yield.

c. The effect of the addition of nitrate of soda.

* The quantities of manure or fertilizer given are in every case the amounts per acre to be applied.

† Complete Fertilizer—a mixture of the best forms of fertilizing constituents, analyzing nitrogen, 4.5 per cent.; phosphoric acid (available), 7.7 per cent., and potash, 13.3 per cent.

‡ An even mixture of ground bone and muriate of potash.

§ An even mixture of ground bone, muriate of potash and acid phosphate.

ASPARAGUS.

s cultivated and crowns uncovered April 11th. y to cutting, April 29th. Cutting began May an in 1900, and was continued until June 26th. plied to plots 1 and 5, December 4th, and at and potash was spread on plots 3, 4, 7 and 8. 4, 6, 7 and 8, received 500 pounds per acre of r, and on June 28th, plots 4 and 8 received ate of 200 pounds per acre. The irrigated plots, June 17th and 24th, applying each time the ll of three-fourths of an inch.

e tabulated results for the season of 1901, the of 1898, 1899 and 1900, and the totals of the d.

y yields are not as uniform as in last season's exceeded all others in seven of the eight plots. year, Palmetto leads on four plots, Conover's noth and Elmira in one each, and on the other s give the same early product. The second given by Barr's Mammoth and Colossal, on two on three, and by Columbian Mammoth White

lmetto exceeds on all plots except 5, where er total. The same results were obtained last t it was exceeded on plot 5 by Barr's Mam-ira. Columbian Mammoth White is second in rr's Mammoth on two, and Elmira on one plot. e of asparagus in our local market averaged 16 d 10.48 cents for the total cut, as against 18½ nts, respectively, for last season. Combining he yields and value per acre of the early and rieties are as follows:

	Early Yield.	Value.	Total Yield.	Value.
....	186.3	$26.83	3,244.9	$306.06
....	224.6	32.35	3,908.5	368.65
ite...........	158.2	22.78	3,163.2	298.35
....	247.6	35.66	5,421.2	487.91
....	193.1	27.81	3,903.4	377.22
....	63.8	9.19	2,126.7	203.99

TABLE 4.

Asparagus.—Fertilizer Plots.

VARIETY.	UNIRRIGATED											
	PLOT 1.			PLOT 2.			PLOT 3.			PLOT 4.		
	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lb
Barr's Mammoth....	14.5	300.0	37.50	28.5	298.5	32.00	20.5	171.5	23.75	16.5	210.0	24
Donald's Elmira....	14.5	364.0	44.75	27.0	286.0	35.25	26.5	300.0	23.25	10.5	207.0	19
Columbian Mammoth White.......	8.5	306.5	45.00	22.0	220.0	31.75	13.0	182.0	28.25	5.0	185.5	21
Palmetto	8.5	497.0	51.25	25.0	403.0	44.75	12.0	391.0	41.00	17.0	332.0	40
Conover's Colossal..	12.5	368.0	37.50	19.5	249.0	26.25	13.5	250.5	23.25	14.5	213.0	22
Giant Brunswick...	5.0	203.5	26.25	11.0	189.0	28.75	4.5	131.5	15.75	7.5	140.5	29
Total	63.5	2039.0	242.25	133.0	1645.5	198.75	90.0	1426.5	155.25	71.0	1288.0	157
Totals for 1898..	68.0	238.5	156.0	95.5	234.5	113.5	76.5	176.5	108.0	67.0	153.0	61
Totals for 1899..	136.0	697.0	109.5	148.0	620.0	76.5	130.0	587.5	76.0	98.0	429.0	71
Totals for 1900..	149.5	1786.5	176.0	229.0	1540.5	118.0	182.0	1389.0	102.0	149.0	1224.0	95
The four years' totals combined	417.0	4761.0	683.75	605.5	4040.5	506.75	478.5	3529.5	441.25	385.0	3085.0	385

Asparagus.—Fertilizer Plots.

VARIETY.	IRRIGATED.											
	PLOT 5.			PLOT 6.			PLOT 7.			PLOT 8.		
	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs	oz.	oz.	lbs.	oz.	oz.	lb
Barr's Mammoth....	10.0	348.0	36.75	4.5	218.5	17.25	9.0	183.0	19.00	6.0	172.5	22
Donald's Elmira....	14.5	367.5	44.75	22.0	325.5	36.75	10.0	218.0	24.25	7.0	229.0	41
Columbian Mammoth White........	5.0	259.5	41.75	18.0	295.5	25.25	14.5	227.0	28.00	7.0	183.0	31
Palmetto	8.5	331.0	43.25	24.0	435.0	43.25	28.5	418.0	24.50	22.0	379.0	40
Conover's Colossal..	18.5	342.5	41.50	11.5	367.0	37.00	12.0	258.0	34.00	11.5	251.0	27
Giant Brunswick...	....	122.0	24.50	3.0	165.0	24.00	1.5	184.5	23.50	5.0	135.0	28
Total	56.5	1770.5	232.50	83.0	1806.5	183.50	75.5	1488.5	153.25	58.5	1349.5	191
Totals for 1898..	72.5	224.5	137.5	100.0	238.5	111.5	84.5	196.5	108.5	77.5	164.5	81
Totals for 1899..	135.0	666.0	116.5	180.0	658.5	87.0	136.5	589.5	77.0	101.5	490.5	66
Totals for 1900..	109.5	1590.5	176.5	206.5	1544.5	136.5	200.0	1447.0	117.0	151.5	1199.0	105
The four years' totals combined...........	373.5	4251.5	663.00	569.5	4248.0	518.50	496.5	3721.5	455.75	389.0	3203.5	443

Palmetto is again the most productive sort, giving 33 pounds in early and 1,512.7 pounds in total yield more than any other. These, however, are the weights as cut in the field. Allowing 10 per cent. for waste in bunching, etc., this increase in yield is commercially worth $3.31 and $110.69 for the early and total yields, respectively. Elmira is second in value of early yield and the Colossal second in value of total product.

Considering the plots, grouping the six varieties together, we have:

a. The unirrigated plots exceed in every case in early yield those irrigated.

In total yield, plots 6, 7 and 8 exceed that of the unirrigated duplicates, while plot 1 exceeds plot 5.

The growth of tops is greater on the unirrigated plots, excepting 4, where that of plot 8, irrigated, is the larger. Combining the yields of the irrigated plots and that of those unirrigated, we find that the latter have given the larger early yield, but in the total yield and growth of tops, the irrigated plots give slightly the larger product.

b. Plots 2 and 6 (complete fertilizer only) have given the largest early cut this season, as well as in the three previous crops. With one exception, plot 1, 1898, plots 3 and 7 (complete fertilizer in spring, with bone and potash in the fall), have given the second largest early yield throughout.

In the total yields the results are the same each year, with one identical exception in 1898 and in the present season, *i. e.*, plot 6 exceeding plot 5. In order, the plots stand as numbered, 1 and 5, 2 and 6, 3 and 7 and 4 and 8, exceptions as above.

In top-growth, the results this season are variable, though 1 and 5 give the largest weight in this, as in previous years.

c. The present season, those plots receiving the additional nitrate have exceeded in early yield only plots 1 and 5. In total cut they have given the lowest yields. With the exception of the early cut upon plot 5, in the years 1898 and 1900, these plots have given the lowest yields throughout the experiment.

Combining the yields of the four crops cut from the plantation, the early yield has been greatest upon the unirrigated plots. The total yield under irrigation is slightly the larger, and in top-growth considerably larger than that on those not irrigated.

In total yield and in growth of tops, the effect of manures and fertilizers are as the plots are numbered, or in order, plots 1 and 5, 2 and 6, 3 and 7, and 4 and 8. The yield, however, of plot 6, is but 3.5 ounces less than that of plot 5—less than one ounce difference for

each crop. The early yields vary somewhat, but the order for those plots not irrigated is 2, 3, 1 and 4, while for those irrigated the order is 6, 7, 8 and 5. Those plots receiving nitrate of soda are lowest in all cases, excepting plot 8, early yield, where it stands third.

Table 5 contains the detailed record of the sub-irrigated row, the two rows set with selected crowns, and the two new sorts, Moore's Cross-Bred and Giant Argenteuil. This is the first season's cut for this last variety, hence the smallness of the yield. The totals for the three previous crops are also given.

TABLE 5.

Asparagus.—New Varieties and Selected Crowns.

VARIETY.	PLOT 1.			PLOT 2.			PLOT 3.			PLOT 4.		
	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.
Donald's Elmira	4.0	290.0	26.25	13.5	276.0	37.75	16.5	225.0	22.50	12.5	210.0	[illegible]
Palmetto	15.5	402.0	55.50	20.0	329.0	35.25	10.5	325.0	42.50	5.0	288.0	[illegible]
Moore's Cross-Bred	7.0	214.0	25.50	12.0	231.0	28.25	14.0	225.0	30.50	6.0	255.0	[illegible]
Giant Argenteuil	1.0	14.0	13.50	8.0	29.0	20.50	17.0	45.0	24.50	4.5	51.0	[illegible]
Sub-irrigated row	....	....	....	14.0	253.5	30.50	20.5	261.5	32.00	11.5	283.5	[illegible]
Total*	27.5	920.0	120.75	53.5	865.0	121.75	58.0	820.0	120.00	28.0	804.0	[illegible]
Totals for 1898*	64.5	152.0	95.0	40.0	117.5	61.5	57.5	140.5	86.0	49.0	119.0	[illegible]
Totals for 1899*	97.0	425.5	59.0	77.5	357.5	49.5	64.0	341.5	47.5	43.5	277.5	[illegible]
Totals for 1900*	102.0	956.0	95.5	78.5	805.5	94.0	81.5	732.5	93.0	71.5	579.0	[illegible]
The four years' totals combined	291.0	2453.5	370.25	249.5	2145.5	326.75	261.0	2034.5	346.50	192.0	1779.5	[illegible]
Sub-irrigated totals combined (1 row)	....	....	....	38.0	516.0	61.50	78.0	585.5	74.00	40.5	553.5	[illegible]

*Sub-irrigated row not included.

The general care of these rows is identical with plots 1 to 4 of the fertilizer plots. The results for the season in early and total yield are the same as already given, *i. e.*, plots 2 and 3 in order for early yield, and plots 1, 2, 3 and 4 in order for the total yield. In growth of tops, however, plot 4, receiving the additional nitrate, exceeds all others. Also in early cut this plot exceeds that of plot 1, though

The combined results for the four years are and in weight of tops. In total cut, however, eady given, *i. e.*, in order, plots 1, 2, 3 and 4. ived from setting the large selected crowns has Palmetto gives identical weights in top-growth y in the permanent plot. In all other cases, the rmanent plots exceed that of the plots where used.

BLACKBERRIES.

lizers were applied as follows: Yard manure, ots 1 and 5, and also bone and potash to plots y 15th, the complete fertilizer was applied on d 8, and on June 12th, nitrate of soda given to plantation was trimmed the 1st of April, and tween the rows was thoroughly cultivated. The ved water but once this season (June 28th), of 1 inch of rainfall was applied.

ne records for the year made as in previous years, als for the crops of 1898, 1899 and 1900, and of the four crops taken from the plantation.

l this season are only about one-third that given fferent varieties, Early Harvest is first in total Eldorado in three and Erie in one. Erie last our plots. The same varieties stand in same best in yield on the different plots, *i. e.*, Early lorado on three and Erie on one. Combining erent varieties upon all the plots and calculating e have the following comparisons, yields given

	Early Yield.	Total Yield.
....	761.33 quarts.	2,156.22 quarts.
....	207.10 "	944.71 "
....	234.52 "	1,391.98 "
....	105.40 "	960.26 "
....	88.29 "	1,166.01 "
....	224.80 "	2,107.60 "

e the greatest yield the past season, with Eldo- 0, Erie was first, with Early Harvest second.

TABLE 6.

Blackberries—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED. PLOT 1. Yield first three pickings.	PLOT 1. Total yield.	PLOT 2. Yield first three pickings.	PLOT 2. Total yield.	PLOT 3. Yield first three pickings.	PLOT 3. Total yield.	PLOT [4]. Yield first three pickings.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.
Early Harvest	July 8.	112.0	292.0	108.0	279.0	95.0	212.0	70.0
Wilson, Jr.	" 20.	63.0	215.0	28.5	167.0	26.0	160.0	18.0
Erie	" 22.	73.0	339.0	35.0	220.0	25.0	174.0	39.5
Agawam	" 22.	5.5	37.0	10.0	186.0	15.0	100.0	28.0
Taylor	" 22.	......	36.0	36.5	245.0	7.5	192.0	5.5
Eldorado	" 20.	18.0	209.0	38.0	500.0	19.0	326.0	36.0
Total	....	271.5	1,128.0	256.0	1,597.0	187.5	1,164.0	197.0
Equivalent in quarts	....	11.3	47.0	10.7	66.5	7.8	48.5	8.2
Totals in quarts for 1898	....	13.3	87.4	16.4	71.5	24.4	87.2	14.8
Totals in quarts for 1899	....	8.9	39.6	10.7	61.3	16.2	101.1	15.0
Totals in quarts for 1900	....	35.7	212.8	32.2	209.6	29.4	196.8	32.8
The four years' totals combined	....	69.2	386.8	70.0	408.9	77.8	433.6	70.8

Blackberries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED. PLOT 5. Yield first three pickings.	PLOT 5. Total yield.	PLOT 6. Yield first three pickings.	PLOT 6. Total yield.	PLOT 7. Yield first three pickings.	PLOT 7. Total yield.	PLOT [8]. Yield first three pickings.
		oz.	oz.	oz.	oz.	oz	oz.	oz.
Early Harvest	July 8.	188.0	382.0	129.5	344.0	123.5	447.0	113.5
Wilson, Jr.	" 20.	68.0	346.0	20.0	139.0	8.0	29.0	24.0
Erie	" 22.	33.0	271.0	49.5	270.0	14.5	86.0	20.0
Agawam	" 22.	25.5	147.0	23.5	260.0	12.0	131.0	10.5
Taylor	" 22.	13.5	244.0	19.5	257.0	13.0	118.0	13.5
Eldorado	" 20.	36.0	371.0	55.0	411.0	25.0	238.0	50.5
Total	....	364.0	1,761.0	297.0	1,681.0	196.0	1,049.0	232.0
Equivalent in quarts	....	15.2	73.4	12.4	70.0	8.2	43.7	9.7
Totals in quarts for 1898	....	27.2	161.1	29.5	103.1	20.8	67.6	20.0
Totals in quarts for 1899	....	18.3	98.7	17.0	148.9	18.0	131.7	16.0
Totals in quarts for 1900	....	41.2	207.0	34.7	195.9	33.8	146.4	29.1
The four years' totals combined	....	101.9	540.2	93.6	517.9	80.8	389.4	74.8

lots, we have:
igated, have given the largest early yield through-
s, the irrigated plots exceed in two cases, and
other two by those not irrigated. Combining
irrigated exceed those not irrigated by almost

the same results were obtained as in last year's
nd 5 first, with 2 and 6 second. In total yield,
gular, plots 2 and 5, 4 and 6, 3 and 8, 1 and 7
roductiveness the past season.
and 8, receiving the extra nitrate of soda are
exceeding only plots 3 and 7, and in total yields
ot irrigated, and 8 is third of those irrigated.
ults of the four crops removed from the planta-
under irrigation exceeds that of the unirrigated
, and in the total by 13.3 per cent.
fertilizers is quite irregular, particularly where
the relations are plots 3, 4, 2 and 1 in early,
in total yields. Under irrigation, the effect in
is the same, *i. e.*, plots 5, 6, 7 and 8.

RASPBERRIES.

to the care of the raspberries was all performed
same dates as those given under blackberries.
o plots 5 to 8 twice during June (the 22d and
ime the equivalent of an inch of rainfall.
ar for the first the two black caps, with the three
d in previous reports.
Cuthbert, in plots 1 and 5, were broken consider-
the winter of 1900 and 1901, so that yields from
what reduced.
pon the different plots, Cuthbert gives the largest
lots, and Souhegan upon the other two. These
1 and 5, where the yield from Cuthbert was re-
nd Turner, in three plots each, have given the
with Souhegan first in the other two. Cuthbert
nd in three each, and Gregg and Souhegan in one

TABLE 7.

Raspberries—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED. PLOT 1. Yield first three pickings.	PLOT 1. Total yield.	PLOT 2. Yield first three pickings.	PLOT 2. Total yield.	PLOT 3. Yield first three pickings.	PLOT 3. Total yield.	PLOT Yield first three pickings.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.
Cuthbert	July 8.	20.5	71.0	108.5	288.0	125.0	288.0	185.0
Marlboro	" 2.	7.0	48.0	24.0	118.0	9.5	97.0	8.5
Turner	" 5.	19.0	164.0	89.0	891.0	60.0	848.0	81.5
Gregg	" 5.	84.0	181.0	22.5	92.0	80.5	98.0	25.0
Souhegan	" 2.	50.5	284.0	27.0	145.0	44.0	186.0	40.0
Total		181.0	698.0	266.0	974.0	269.0	962.0	290.0
Equivalent in quarts		6.0	81.7	12.1	44.8	12.2	48.7	18.2
Totals in quarts for 1898*		7.0	28.7	2.4	11.7	2.4	11.4	2.6
Totals in quarts for 1899*		12.4	88.4	6.1	87.2	6.0	88.8	8.0
Totals in quarts for 1900*		2.9	88.6	7.7	46.8	5.8	49.5	8.2
The four years' totals combined		28.8	127.4	28.8	140.0	26.4	142.9	22.0

* Three varieties only.

Raspberries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED. PLOT 5. Yield first three pickings.	PLOT 5. Total yield.	PLOT 6. Yield first three pickings.	PLOT 6. Total yield.	PLOT 7. Yield first three pickings.	PLOT 7. Total yield.	PLOT Yield first three pickings.
		oz.	oz.	oz.	oz	oz.	oz.	oz.
Cuthbert	July 8.	51.0	142.0	94.0	212.0	129.0	288.0	120.5
Marlboro	" 2.	4.5	28.0	18.0	98.0	8.0	64.0	6.0
Turner	" 5.	29.0	285.0	58.0	804.0	25.5	287.0	80.5
Gregg	" 5.	87.5	168.0	17.0	50.0	57.0	166.0	11.0
Souhegan	" 2.	80.0	290.0	68.0	199.0	77.0	255.0	48.0
Total		202.0	858.0	250.0	858.0	296.5	1,010.0	216.0
Equivalent in quarts		9.2	89.0	11.4	89.0	18.5	45.9	9.8
Totals in quarts for 1898*		8.7	41.5	2.9	14.0	2.8	18.6	2.2
Totals in quarts for 1899*		12.0	40.6	7.8	89.8	6.0	41.5	6.0
Totals in quarts for 1900*		4.5	87.6	5.5	40.5	4.8	47.4	8.9
The four years' totals combined		84.4	158.6	27.1	182.8	27.1	148.4	21.9

* Three varieties only.

Combining, as in previous cases, these five varieties give the following yields in quarts per acre:

	Early Yield.		Total Yield.	
Cuthbert	102.15	quarts.	2,325.43	quarts.
Marlboro	99.28	"	753.26	"
Turner	422.34	"	2,734.74	"
Gregg	289.15	"	1,046.75	"
Souhegan	535.69	"	1,943.24	"

Considering the results by plots:

a. The irrigated plots give the largest early yield in two cases, and in total yield in one case only. Combining the yields of the plots not irrigated, and that of those irrigated, the latter give slightly larger yields both in the early and total.

b. The results with the different fertilizers are very irregular. In early yields, plots 4 and 7 are best, with 3 and 6 second. In total yields 5 and 6 are identical, plots 2 and 7 lead, with 3 and 5 and 6, second.

c. Where nitrate of soda was added to the unirrigated plots, the early yield is the largest, and in total yield, third in order. Where irrigated, it is third in early yield and lowest in total yields.

Considering the results of the four crops harvested, the irrigated plots have given yields but little larger than where no water was applied. The effect of the different fertilizers is very irregular, plot 3 being best where unirrigated, and plot 5 of those irrigated. Nitrate of soda added has given the lowest returns throughout.

CURRANTS AND GOOSEBERRIES.

Manures and fertilizers were applied to these fruits as follows: Yard manure, December 4th, to plots 1 and 4, and the bone, potash and acid phosphate mixture at the same time on plots 2, 3, 5 and 6. Nitrate of soda was applied to plots 3 and 6, May 8th. The bushes were trimmed the second week in April, and the spaces between the rows thoroughly cultivated May 1st.

The irrigated plots received water three times, June 19th, 25th and July 1st, applying the equivalent of three-fourths of an inch of rainfall the first time, and one inch the other times.

Table 8 contains the records for the year, together with that of the last three years, and the four crops combined.

TABLE 8.

Currants—Fertilizer Plots.

VARIETY.	UNIRRIGATED.			IRRIGATED.	
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.
	oz.	oz.	oz.	oz.	oz.
Fay's Prolific	441.0	509.0	320.0	430.0	247.0
Red Dutch	732.0	603.0	330.0	809.0	818.0
Victoria	672.0	528.0	650.0	752.0	658.0
White Grape	352.0	319.0	860.0	604.0	376.0
Total	2,197.0	1,959.0	2,160.0	2,595.0	2,099.0
Equivalent in quarts	109.9	98.0	108.0	129.8	105.0
Totals in quarts for 1898	13.3	3.4	8.8	17.8	11.3
Totals in quarts for 1899	41.2	37.5	49.8	51.8	51.6
Totals in quarts for 1900	62.7	61.0	53.9	82.0	68.1
The four years' totals combined	227.1	199.9	220.5	281.4	236.0

Gooseberries—Fertilizer Plots.

VARIETY.	UNIRRIGATED.			IRRIGATED.	
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.
	oz.	oz.	oz.	oz.	oz.
Downing	227.0	127.0	107.0	140.0	135.0
Columbus	228.0	144.0	118.0	203.5	160.0
Houghton	376.0	336.0	331.0	508.5	526.0
Triumph	278.0	213.0	179.0	186.0	133.0
Total	1,109.0	820.0	785.0	1,038.0	954.0
Equivalent in quarts	47.2	34.9	31.8	44.2	40.6
Totals in quarts for 1898	29.7	22.9	26.4	37.5	21.8
Totals in quarts for 1899	86.3	47.5	74.6	70.6	59.5
Totals in quarts for 1900	158.7	98.2	125.0	161.9	128.4
The four years' totals combined	321.9	203.5	257.8	314.2	254.8

Currants.—Red Dutch has been the most productive variety upon each of the plots, and Victoria second. The yields per acre are as follows:

Fay's Prolific......	5,049.99 quarts	Victoria	8,456.20 quarts.
Red Dutch	9,741.69 "	White Grape...	5,176.56 "

Considered by plots, we have:

a. Irrigation has given an increase on two of the three plots. Combining the yields in each case, the increase due to irrigation equals a little over 8 per cent.

b. Plots 1 and 4, receiving yard manure, have given the largest yields, plots 3 and 6 next, with 2 and 5 lowest.

c. Nitrate of soda, on plots 3 and 6, are second in yield this year. In previous years, these plots have given the lowest yields, excepting where unirrigated (plot 3), in 1898 it was second, and in 1899 first in yield. Combining the four seasons' yields, the irrigated plots have given yields a little over 15 per cent. larger than given when not irrigated. Plots 1 and 4, 3 and 5, 2 and 6, is the order of productiveness of the plots. The nitrated plots are second when not irrigated, and lowest where irrigation is practiced.

Gooseberries. The extremely hot weather of the last of June and first of July injured this fruit very materially, a greater part dropping to the ground. Because of the experiment, these were picked up as carefully as possible and weighed separately. The records show that 70.48 per cent. of the crop was thus injured. It is interesting to note that while the injury was great on all plots, it was not as severe where irrigated. When picked, there was on the bushes of the unirrigated plots, 23.3 quarts, and on those irrigated, 48.4 quarts. Houghton seemed to withstand the effects of the heat better than any of the other varieties, particularly where irrigated. Commercially, however, irrigation will not save a crop when we have temperatures of 100 to 103 degrees.

Considering the plots, we find that:

a. Irrigation has increased the yields in two of the three plots.

b. Yard manure, plot 1 of the unirrigated plots, and plot 6, chemical fertilizers, give the largest yields.

c. Nitrate of soda added gives the lowest results where not irrigated, and highest where irrigated.

Combining the four crops, the increase due to irrigation equals a little over 7 per cent. An increase, however, occurs on two plots

only; plot 1, yard manure, unirrigated, exceeds plot 3, the irrig duplicate. Yard manure has given the largest yields; with tl plots receiving nitrate of soda in addition to the bone, potash acid phosphate mixture second, both were irrigated and not irriga

STRAWBERRIES—FERTILIZER PLOTS.

The plants in the fertilizer plots were set the last of August, 18 fruit was produced in 1900 only on the original plants set. Du the season of 1900, good matted rows were formed in every c Fertilizers, as outlined, were applied April 30th, and on June nitrate of soda applied to plots 2, 3, 6 and 7. The irrigated p received water four times, giving at each application the equiva of a rainfall of .50, .75, .75 and 1.00 inch.

Table 9 contains the results for the year. The previous record the fertilizer work with strawberries is also included, and covers crops of 1897, 1898 and 1900.

TABLE 9.

Strawberry—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED.							
		PLOT 1.		PLOT 2.		PLOT 3.		PLOT 4.	
		Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.
		oz.	oz	oz	oz.	oz.	oz.	oz.	oz.
harpless	June 13.	92.5	326.0	112 0	318.0	71.0	234.0	35.0	241.0
ubach	" 8.	100.5	517.0	121.0	500.0	103.0	706.0	48.0	570.0
owning	" 8.	54 0	321.0	55.0	404.0	24.5	283.0	34.5	408.0
len Mary	" 11.	107.5	614.0	97.0	644.0	62.5	534.0	86.0	640.0
andy	" 17.	92.5	352.0	86.0	331.0	39.0	277.0	57.0	293.0
arshall	" 11.	67.5	313.0	77.5	347.0	78.0	350.0	83.5	381.0
Total		514.5	2443.0	548.5	2544.0	378.0	2384.0	344.0	2533.0
quivalent in quarts		27.1	128.6	28.9	133.9	19.9	125.5	18.1	133.3
Totals in quarts for 1897		16.4	86.2	14.5	91.2	12.1	81.0	12.3	78.6
Totals in quarts for 1898		26.0	64.7	24.9	58.5	20.2	42.4	17.0	36.3
Totals in quarts for 1900		7.5	25.5	8.9	26.9	6.6	17.1	5.0	15.0
The four years' totals combined		77.0	305.0	77.2	310.5	58.8	266.0	52.4	263.2

Strawberry—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED.							
		PLOT 5.		PLOT 6.		PLOT 7.		PLOT 8.	
		Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
harpless	June 13.	56.0	177.0	69.5	201.0	63.5	214.0	44.0	126.0
ubach	" 8.	80.5	508.0	153.5	517.0	85.5	333.0	113.0	577.0
owning	" 8.	41.0	243.0	44.0	190.0	46.5	228.0	36.5	363.0
len Mary	" 11.	83.0	508.0	142.5	767.0	70.5	575.0	91.0	622.0
andy	" 17.	66.0	360.0	83.5	365.0	57.0	293.0	62.0	358.0
arshall	" 11.	35.5	210.0	53.5	251.0	40.0	159.0	64.0	349.0
Total		362.0	2006.0	546.5	2291.0	363.0	1802.0	410.5	2395.0
quivalent in quarts		19.1	105.6	28.8	120.6	19.1	94.8	21.6	126.1
Totals in quarts for 1897		16.8	76.8	12.8	56.1	16.1	82.8	17.8	87.9
Totals in quarts for 1898		27.6	61.5	25.0	62.6	25.4	49.2	20.7	40.3
Totals in quarts for 1900		5.6	19.1	7.6	20.3	7.7	20.4	6.4	17.4
The four years' totals combined		69.1	263.0	74.2	259.6	68.3	247.2	66.5	271.7

Of the varieties, Bubach gives the largest early yield on five and Glen Mary on three plots. In total yields, Glen Mary leads on six plots, Bubach on one, and they are the same in the eighth case. Yields per acre for these varieties are as follows:

	Early Yield.		Total Yield.	
Sharpless	973.29	quarts.	3,290.12	quarts.
Bubach	1,441.89	"	7,572.92	"
Downing	601.67	"	4,370.26	"
Glen Mary	1,325.51	"	8,783.74	"
Gandy	972.61	"	4,708.87	"
Marshall	894.67	"	4,226.99	"

Grouping the varieties by plots:

a. The unirrigated plots lead in yield in all cases, excepting early yield on plot 4, which is exceeded by its irrigated duplicate.

b. Plots 2 and 6 give the largest early yields, with 1 and 8 second. In total yields, plots 2 and 8 are the largest, with 4 and 6 second.

c. When nitrate of soda is added to the complete fertilizer, plots 2 and 6, an increase in yield results; when added to the mixture of bone, potash and acid phosphate, plots 3 and 7, an increase occurs only in early yield on the unirrigated plots.

Combining the four crops, irrigation has given a small increase in early yield only. The complete fertilizer with nitrate added has given the best results in early yields, and in totals on the unirrigated plots. Bone, potash and acid phosphate alone gave the largest yields under irrigation.

STRAWBERRIES—VARIETIES.

The variety test of last year was continued, and the plants fruited for the second time this season. After fruiting last year, the bed was cleaned, mulched in due time, and early the past spring a good application of a complete fertilizer given the bed. The bed was also irrigated twice, giving each time the equivalent of an inch of rainfall. The records were made as last year, and are given in table 10. Many of the plants set as hills failed to live for the second year's fruiting. The number living in each case is indicated in the third column of table.

Comparing hills versus matted rows, using as the basis the yields er acre, there are nineteen varieties that this year have given greater turns from hills than from matted rows, as against eleven in 1900. hese are given below, with the yields over and above that given on ie matted rows :

Hall's Favorite...	4,553 5	quarts.	Saunders	1,305.5	quarts.
*Warfield............	3,263.5	"	*Ridgeway...........	1,114.5	"
*Johnson's Early...	2,515.5	"	Michel's Early....	1,089.0	"
*Lady Thompson...	2,213.5	"	Glen Mary.........	1,067.0	"
*Parker Earle	2,213.0	"	*Wm. Belt...........	1,067.0	"
Jerry Rusk..	2,085.5	"	Tennessee..........	1,050.5	"
Enhance.............	1,926.5	"	Margaret...........	589.5	"
*Hunn	1,719.0	"	Gandy	589.0	"
Seaford..	1,656.0	"	Ocean City....	111.5	"
Nick Ohmer.......	1,337.5	"			

The variety, Jerry Rusk, should hardly be included as above, nce a considerable part of the matted row had failed. Ideal, xcelsior and Bubach are very nearly equal in yields obtained from ie hills and matted rows. Starr gives upon the matted rows nearly ouble, and Bismark and Gladstone more than twice that obtained om hills. Bismark did the same last year. Without question, me varieties are better adapted to hill culture than others, and of iose varieties given above as yielding better under hill culture, iose that have given the same results for the two years may be garded as the most desirable varieties for growing in hills.

* Exceeded the matted rows in 1900.

TABLE 10.

Strawberries—Varieties.

VARIETY.	Perfect or imperfect flowers.	HILLS, TWENTY-FOUR SQUARE FEET TO EACH VARIETY.					
		Date first picking.	Number plants fruited.	Yield before June 12.	Total yield.	Yield after June 25.	Total yield per acre in quarts.
				oz.	oz.	oz.	qts.
Bederwood	Per.	June 11.	17	6.0	38.0	2.0	3,6
Bismark	"	" 11.	7	12.5	27.0	....	2,57
Bubach	Imp.	" 8.	8	9.0	90.0	14.5	8,5
Corsican	Per.	" 11.	9	5.0	67.0	12.0	6,4
Carrie	Imp.	....	....	....	....	....	....
Clyde	Per.	" 13.	14	....	7.0	0.5	6
Cobden Queen	Imp.	" 11.	11	4.0	33.5	1.5	3,2
Darling	Per.	" 8.	14	21.0	63.5	1.0	6,0
Enhance	"	" 13.	16	0.5	62.5	14.5	5,97
Enormous	Imp.	" 11.	8	4.5	43.0	1.0	4,10
Excelsior	"	" 8.	13	29.5	63.0	1.5	6,01
Gandy	"	" 17.	16	....	27.0	7.5	2,57
Gladstone	"	" 19.	4	....	16.0	4.5	1,5
Glen Mary	"	" 11.	15	1.0	81.5	6.5	7,7
Hall's Favorite	"	" 11.	14	14.0	80.5	4.0	7,6
Hunn	"	" 19.	14	....	49.5	22.5	4,7
Ideal	Per.	" 8.	16	4.0	97.0	8.5	9,2
Jerry Rusk	"	" 11.	2	....	81.5	....	8,0
Johnson's Early	"	" 8.	17	8.0	48.5	4.5	4,6
Lady Thompson	"	" 11.	15	6.0	38.5	3.0	3,6
Manwell	"	....	....	....	....	....	....
Margaret	"	" 11.	17	4.5	117.0	17.0	11,1
Michel's Early	"	" 8.	14	7.0	29.0	1.5	2,7
Nick Ohmer	"	" 11.	18	1.5	50.5	7.5	4,8
Ocean City	Imp.	" 13.	6	....	22.5	....	2,1
Parker Earle	"	" 13.	15	....	48.5	7.0	4,6
Pride of Cumberland	"	" 11.	17	4.5	43.0	5.0	4,1
Ridgeway	"	" 11.	18	0.5	56.0	18.5	5,3
Sample	"	" 11.	18	2.5	52.5	6.5	5,0
Saunders	Per.	" 11.	3	6.0	33.0	....	3,1
Seaford	Imp.	" 11.	18	1.5	74.0	9.0	7,0
Starr	Per.	" 11.	15	0.5	36.5	8.0	3,4
Tennessee	"	" 13.	17	....	65.0	11.0	6,2
Warfield	Imp.	" 11.	16	4.0	56.5	4.0	5,3
Wm. Belt	Per.	" 13.	17	....	59.5	9.5	5,6

TABLE 10—Continued.

Strawberries—Varieties.

VARIETY.	Perfect and imperfect flowers.	MATTED ROWS, SEVENTY-TWO SQUARE FEET TO EACH VARIETY. Date first picking.	Yield before June 12.	Total yield.	Yield after June 25.	Total yield per acre in quarts.	Runner production, 10=max'm.
			oz.	oz.	oz.	qts.	
derwood	Per.	June 11.	4.0	180.5	16.5	5,747.5	9.5
smark	"	" 13.	....	206.0	9.0	6,559.5	9.5
bach	Imp.	" 11.	6.5	274.0	27.5	8,724.5	8.0
rsican	Per.	....	....	....	....	....	....
rrie	Imp.	" 11.	2.0	71.0	8.0	2,261.0	8.0
yde	Per.	" 11.	3.5	84.5	5.0	2,690.5	7.0
bden Queen	Imp.	" 11.	6.0	143.5	7.0	4,569.5	10.0
rling	Per.	" 8.	28.5	234.5	10.5	7,467.0	8.5
hance	"	" 11.	2.0	127.0	33.5	4,044.0	9.0
ormous	Imp.	" 11.	4.0	157.5	18.0	5,015.0	5.0
celsior	"	" 8.	83.0	198.0	6.0	6,304.5	8.5
ndy	"	" 15.	....	62.5	25.0	1,990.0	7.0
adstone	"	" 13.	....	110.0	40.0	3,502.5	8.0
en Mary	"	" 11.	2.0	211.0	24.5	6,718.5	8.5
all's Favorite	"	" 11.	14.0	98.5	9.0	3,136.5	7.0
inn	"	" 11.	8.0	94.5	33.0	3,009.0	5.0
eal	"	" 8.	2.5	303.0	35.0	9,648.0	8.0
rry Rusk	"	" 11.	4.0	29.0	1.0	923.5	8.0
hnson's Early	"	" 8.	1.0	66.5	10.0	2,117.5	10.0
dy Thompson	"	" 11.	4.0	46.0	8.0	1,464.5	3.0
anwell	"	" 11.	7.0	58.5	3.0	1,863.0	9.5
argaret	"	" 11.	5.5	332.5	33.0	10,587.0	6.0
ichel's Early	"	" 8.	16.5	52.5	1.0	1,671.5	9.0
ck Ohmer	"	" 11.	11.0	109.5	11.0	3,486.5	4.0
ean City	"	" 13.	....	64.0	7.5	2,038.0	7.5
arker Earle	Per.	" 11.	0.5	76.0	13.5	2,4[illegible]0.0	3.0
ide of Cumberland	"	" 11.	5.0	187.0	20.5	5,954.5	5.0
dgeway	"	" 11.	0.5	133.0	40.5	4,235.0	8.0
mple	Imp.	" 11.	3.0	262.5	43.0	8,358.5	10.0
unders	Per.	" 11.	8.0	58.0	2.5	1,847.0	7.5
aford	Imp.	" 11.	1.0	170.0	14.5	5,413.0	8.0
arr	Per.	" 13.	4.5	194.0	30.0	6,177.5	6.0
ennessee	"	" 13.	....	162.0	19.5	5,158.5	10.0
arfield	Imp.	" 11.	1.5	67.0	6.0	2,133.5	10.0
m. Belt	Per.	" 11.	2.0	145.0	22.0	4,617.0	9.5

Of the early sorts, Excelsior is by far the most productive this ye
with Darling second.

In the late varieties, Sample leads in yield, after June 25th, as
did in 1900. Ridgeway and Gladstone are next in yield.

The half dozen most productive varieties grown as hills and
matted rows, are:

Hills	Matted Rows.
*Margaret,	Margaret,
Ideal	Ideal,
Bubach,	*Bubach,
Glen Mary,	*Sample,
Halls Favorite,	Darling.
Seafard,	Glen Mary,
*Corsican,	*Bismark,
Darling,	Excelsior.

Margaret and Corsican (Big Berry) are the only ones of the hi
and Bubach, Sample and Bismark of the matted row lots that w
included in the eight best in 1900.

THE THREE FRUITS.

The general plan is repeated, *i. e.*, the plots extend crosswise t
rows, so that each plot includes two trees of each row; each r
being a different variety. A cross-line of trees is set between t
plots to prevent interfeeding by roots of trees extending into adjac
plots, and to test some of the newer varieties of the different t
fruits. Thus arranged, trees 1, 2, 4, 5, 7, 8, 10 and 11 of each r
are included in plot work, while 3, 6, 9, etc., are the newer varieti
Table 11 shows detailed plan of fertilizers, amounts and times
application.

* In the similar list for 1900.

TABLE 11.

r, Amounts and Time of Application for the Various Fruit Trees.

ot 1.	Plot 2.	Plot 3.	Plot 4.
g.	500 lbs.‖ B. P. & A. P.† applied in spring.	500 lbs. B. P. & A. P. applied in spring.	
g.	500 lbs. B. P. & A. P. applied in spring.	500 lbs. B. P. & A P. applied in spring; 150 lbs. nitrate soda applied early and turned under.	500 lbs. P. & A. P.‡ applied in spring; 150 lbs. nitrate soda applied early and turned under.
g.	500 lbs. B. P. & A. P. applied in spring.	500 lbs. B. P. & A. P. applied in spring. 150 lbs. nitrate soda applied early and turned under.	
l and 4.*	Plots 2 and 5.	Plots 3 and 6.	
g.	500 lbs. B, P. & A. P. applied in spring.	500 lbs. B P. & A. P. applied in spring; 150 lbs. nitrate soda applied early and turned under.	
l and 3.*	Plots 2 and 4.		
B. P. & A. pplied in g.	500 lbs. B. P. & A. P. applied in spring. 150 lbs nitrate soda applied early and turned under.		

izers given are in all cases the amount per acre to be applied.
ound bone, muriate of potash and acid phosphate.
of potash and acid phosphate in the proportion of 1 lb. of the former

f Pears, and 1 and 2, Plums and Cherries, are irrigated as occasion

ere trimmed during March. Nitrate of soda was
heme May 14th and 15th, and the ground plowed.
eral application of fertilizers was made and har-
plots to be irrigated, *i. e.*, plots 1 and 2, plums and
2 and 3, dwarf pears, received June 29th, water
ne-half inches of rainfall.

PLUMS AND CHERRIES.

Of the plums, Newman of the varieties in plots and Burbank an Satsuma Blood of the newer sorts, are the only ones fruiting thi season. Early Richmond of the cherries gave a fair crop; the othe two varieties in plots yielding but little fruit. Of the varietie English Morello and Montmorency Ordinaire gave fair crops, wit four others yielding a small quantity. Tables 12 and 13 contain th records for the year, together with totals of all previous crops.

TABLE 12.

Plums and Cherries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED. PLOT 1. TREE 1. Total yield.	IRRIGATED. PLOT 1. TREE 2. Total yield.	IRRIGATED. PLOT 2. TREE 1. Total yield.	IRRIGATED. PLOT 2. TREE 2. Total yield.	UNIRRIGATED. PLOT 3. TREE 1. Total yield.	UNIRRIGATED. PLOT 3. TREE 2 Total yield.	UNIRRIGATED. PLOT 4. TREE 1. Total yield.	UNIRRIGATED. PLOT 4. TREE Total yield.
Plums.		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz	lbs. oz.	lbs. oz.	lbs. o
Newman	Aug. 8–29.	8— 6	2— 2	8—14	10— 6	6— 6	9— 6	0—15	1—
Totals for 1899*	....	8— 6	22— 1	11— 5	22— 1	40—11	5—12	8— 5	2—
Totals for 1900†	....	41— 6	71— 7	42— 9	129—10	146— 4	86— 8	20— 8	15—
Totals for plots combined	....	143—12	....	219—18	....	244—15	....	43— 5	....
Cherries.									
Large Montmorency	July 18.	0— 4	....	0— 1	0— 2	0— 1	0— 1	0— 8	....
Louis Philippe	" 5.	0— 5	0—18	0— 4	0— 1	0— 1	0— 1	0— 2	....
Early Richmond	June 27.	0— 9	7—14	8— 7	10—10	4— 0	8—10	8— 9	4—1
Total	....	1— 2	8—11	8—12	10—13	4— 2	8—12	4— 8	4—1
Totals for 1899‡	....	0— 1	0— 8	0— 1	0— 7	0— 5	0— 5	0— 2	0—
Totals for 1900§	....	1— 1	9— 1	8— 2	6—10	7—15	9—12	4— 1	4—
Totals for plots combined	....	20— 8	....	24—18	....	81— 8	....	17—10	....

* Two varieties fruiting.
† Four varieties fruiting.
‡ One variety fruiting.
§ Three varieties fruiting.

TABLE 13.

Plums and Cherries—Varieties.

Date first picking.	TREE 1. Total yield.		TREE 2. Total yield.		VARIETY—CHERRIES.	Date first picking.	TREE 1. Total yield.	TREE 2. Total yield.
	No. fts.	oz.	No. fts.	oz.			lbs oz.	lbs. oz.
ug. 16.	7	11	25	39	Ostheim	July 5.	1—15	0—6
" 16.	5	5	18	18	Royal Duke	" 5.	0— 3	0—4
					English Morello	" 13.	6— 3	4—5
					Montmorency Ordinaire	" 5.	9— 0	16—1
					Reine Hortense	" 5.	C— 6	0—3
					May Duke	" 5.	0— 4	0—3

nents have not been continued long enough to war- conclusions. However, considering the totals up s combined for each plot, plot 3 in each case has yield. Where irrigated, nitrate of soda added has eased yields, while upon the unirrigated plots that he additional nitrate has given the lowest yields each fruit, one of the irrigated plots exceeds, and the its unirrigated duplicate. Combining the two plots irrigated plots of the plums and unirrigated plots ave given the largest yields.

es, the Burbank plum set a good quantity of fruit. rst, and the brown rot later took the crop. The ency Ordinaire seems to be a desirable variety of s.

DWARF PEARS.

the fertilizer plots and of the variet:es are given in respectively.

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TABLE 14.

Dwarf Pears—Fertilizer Plots.

VARIETY.	IRRIGATED.											
	PLOT 1.				PLOT 2.				PLOT 3.			
	TREE 1.		TREE 2.		TREE 1.		TREE 2.		TREE 1.		TREE 2.	
	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No fruits.	Weight.
Dwarfs proper.		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz.		lbs. o
Lawrence	14	8— 4	.....	.....	.....	.....	1	0— 4	2	0—7	.....	.....
Bartlett	.....	.....	.....	.....	18	2 —9	4	1— 1	9	2—7	6	1—
Dwarfs by cutting.												
Lawrence	.....	.....	2	0—10	.....	.....	.....	.....	6	2—7	.....	.....
Bartlett	.....	.....	4	0—14	.....	.....	.....	.....	.....	.....	18	2—1
Keiffer	47	14— 4	2	0—10	14	4—12	7	2— 7	22	8—4	9	3—1
Total	61	17— 8	8	2— 2	27	7— 5	12	3—12	39	12—9	28	8—
Totals for 1900	81	9—14	.....	.....	48	13— 4	125	36— 6	43	12—2	41	12—1

Dwarf Pears—Fertilizer Plots.

VARIETY.	UNIRRIGATED.											
	PLOT 4.				PLOT 5.				PLOT 6.			
	TREE 1.		TREE 2.		TREE 1.		TREE 2.		TREE 1.		TREE 2.	
	No. fruits.	Weight.	No fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.
Dwarfs proper.		lbs. oz		lbs. oz		lbs. oz.		lbs. oz.		lbs. oz.		lbs. o
Lawrence	1	0— 4	.....	.....	.....	.....	1	0— 4	.....	.....	.....	.....
Bartlett	1	0— 6	.....	.....	19	5— 0	11	3— 8	2	0— 7	.....	.....
Dwarfs by cutting.												
Lawrence	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bartlett	4	0—15	.....	.....	.....	.....	.....	.....	1	0— 5	.....	.....
Keiffer	34	12— 8	16	4—8	7	2—11	15	5—13	19	6—10	.....	.....
Total	40	13—12	16	4—8	26	7—11	27	9— 9	22	7— 6	.....	.....
Totals for 1900	82	25—14	50	13—9	6	2— 0	108	26—12	16	3—12	.....	.....

TABLE 15.

Dwarf Pears—Varieties.

IETY.	Tree 1. No. fruits.	Tree 1. Weight.	Tree 2. No. fruits.	Tree 2. Weight.
		lbs. oz.		lbs. oz.
....	....	....	1	0— 5
....	4	2— 9	2	1—12
....	1	0— 5	3	0—12
....	4	0— 9	....	....
....	24	8—13	22	7—14
....	....	....	4	1—15

is insufficient to permit any definite conclusions, g as yet given by any of the varieties. In the verage weight per fruit was for the irrigated plots not irrigated, 4.48 ounces. This season the fruit d plots averages the heaviest, or 5.24, as against se irrigated. The irrigated plots exceed in yield, irrigated plots, and combined, the irrigated plots e unirrigated by a little over 19 per cent. The ne exception, have given larger yields than those

STANDARD PEARS.

contain the data of the year's yield, together with re presented as a matter for record. It may be blank, has so far given the largest yield, thus t frequently made that young trees on good soils, crop is grown, do not need applications of fer- he trees begin to bear more heavily, fertilizers ntageously.

TABLE 16.

Standard Pears—Fertilizer Plots.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.		
	TREE 1.		TREE 2.		TREE 1.		TREE 2.		TREE 1.		TREE 2.
	No. fruits.	Weight.	No. fruits	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.	Weight.	No. fruits.
		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz.	
Lawrence	......	....	1	C— 6	......	....	......	....	1	C— 4	.....
Bartlett	......	....	......	....	30	7— 0	1	0— 4	2	0— 9	28
Keiffer	73	27—7	156	56—14	86	32—12	62	22— 8	130	48—10	87
Total	73	27—7	157	57— 4	116	37—12	63	22—12	133	49— 7	110
Totals of 1900	69	22—0	94	29— 6	9	2—14	149	49— 0	54	17— 0	67

TABLE 17.

Standard Pears—Varieties.

VARIETY.	TREE 1.		TREE 2.	
	No. fruits.	Weight.	No. fruits.	Weight.
		lbs. oz.		lbs.
Koonce	....	....	10	2—
P. Barry	....	....	12	4—
Dorset	4	1— 8	10	2—
Angel	1	0— 7	1	0—
Winter Nelis	19	8—15	2	0—
Keiffer (Stringfellow)	....	....	17	6—

PEACHES—FERTILIZER PLOTS.

The general treatment of the orchard has already been outli The detailed records of the year, together with the totals of the previous crops, are presented in Table 18. In the last column of records for each tree, there is given the number of fruits remo

	Date first pick	No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	Average size N and 2, respecti		No. removed i thinning.	Date first pick	No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	Average size N and 2, respecti		No removed i thinning.
			lbs. oz.		lbs. oz.		lbs. oz.	oz.					lbs. oz.		lbs oz.		lbs. oz.	oz.		
Susquehanna	Sept. 9.	67	17—12	24	3—14	8	0—12	4.2	2.6	340	Sept, 9.	62	14— 1	49	7—14	47	2—11	3.6	2.6	550
Stevens' Rareripe	" 28.	10	1—11	321	37—11	66	4—15	2.7	1.9	446	" 28.	4	0—10	198	20— 0	44	3— 0	2.5	1.7	288
Elberta	" 7.	328	77—13	83	13—14	20	2— 5	3.8	2.7	496	" 9.	299	57— 5	300	42— 4	47	4—12	3.1	2.8	547
Crawford's Late	" 16.	54	10— 4	52	7— 4	14	1— 8	3.0	2.2	8	" 16.	144	25—11	117	15—13	81	2—10	2.9	2.2	55
Reeves' Favorite	" 5.	117	26— 0	39	5—15	5	0— 9	3.6	2.4	157										
Old Mixon	" 9.	220	43— 8	281	30— 2	48	3—14	3.2	2.2	541	" 9.	24	3—13	484	50—10	81	6— 5	2.5	1.9	366
Total		796	176—11	800	107—12	156	13—15	3.6	2.2	1,988		*654	126—13	1,265	158—12	287	22— 6	3.1	2.0	2,145
Total for 1899		169	40— 8	169	24—11	33	3— 3			35		165	52—10	397	70—13	91	10— 1			177
Total for 1900		1,407	229— 7	1,414	139—15	276	18— 1			842		1,315	185— 8	3,173	249— 9	726	35— 6			1,099
Total, excluding Stevens' Rareripe		786	175— 0	479	70— 1	90	9— 0	3.6	2.3	1,542		*649	125—15	1,025	133— 8	233	18—11	3.1	2.1	1,796
Total for 1899		109	26— 9	66	10—11	13	1— 6					140	40— 2	237	46— 5	54	6— 8			108
Total for 1900		856	184— 7	522	73—14	98	9— 8			377		1,228	154— 1	2,088	178— 1	478	25— 0			572

* Calculated for full plot, 1 tree out.

TABLE 18—Continued.

Peaches.—Fertilizer Plots.

VARIETY.	PLOT 2.																			
	TREE 1.										TREE 2.									
	Date first picking.	TOTAL YIELD.						Average size Nos. 1 and 2, respectively.		No. removed in thinning.	Date first picking.	TOTAL YIELD.						Average size Nos. 1 and 2, respectively.		No. removed in thinning.
		No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.					No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.			
			lbs. oz.		lbs. oz.		lbs. oz.	oz.					lbs. oz.		lbs. oz.		lbs. oz.	oz.		
Susquehanna	Sept. 9.	59	11—12	118	16— 6	42	2— 9	3.2	2.2	450	Sept. 8.	15	3— 5	16	2— 4	21	1—15	3.5	2.3	108
Stevens' Rareripe	" 28.	....	....	46	3—11	13	0—14	.....	1.3	15	" 28.	37	5—15	269	30— 4	29	2— 1	2.6	1.8	410
Elberta	" 9.	140	26— 5	136	19— 1	20	2— 3	3.0	2.2	198	" 9.	103	18— 5	203	27— 6	19	1—15	2.8	2.2	421
Crawford's Late	" 16.	123	22—11	149	19—12	18	1—15	3.0	2.1	67	" 16.	49	8—15	90	12—10	13	1— 9	2.9	2.2	19
Reeves' Favorite	" 3.	23	3—10	42	5—14	3	0— 6	2.5	2.2	9	" 5.	109	23— 5	36	5— 8	6	0—10	3.4	2.4	72
Old Mixon	" 9.	257	47—11	156	20—15	26	2— 7	3.0	2.1	637	" 9.	258	40—11	426	53—14	82	6—14	2.5	2.0	650
Total	....	602	112— 1	647	85—11	122	10— 6	3.0	2.1	1,376	....	571	100— 8	1,040	131—14	170	15— 0	2.8	2.0	1,680
Total for 1899	....	267	67—10	287	51—12	54	6— 4	....	.....	97	....	213	54— 1	888	71— 0	63	8— 1	....	.....	234
Total for 1900	....	1,756	191— 6	1,887	146— 5	356	17—11	....	.....	926	....	1,204	168— 1	2,192	220— 8	358	25— 1	.....	....	1,003
Total, excluding Stevens' Rareripe	....	602	112— 1	601	82— 0	109	9— 8	3.0	2.0	1,361	....	534	94— 9	771	101—10	141	12—15	2.8	2.1	1,270
Total for 1899	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	130

VARIETY.	Date first picking.	TOTAL YIELD. No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	Average size Nos. 1 and 2, respectively.		No. removed in thinning.	Date first picking.	TOTAL YIELD. No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	Average size Nos. 1 and 2, respectively.		No. removed in thinning.
			lbs. oz		lbs. oz.		lbs. oz.	oz.					lbs. oz.		lbs. oz.		lbs. oz.	oz.		
Susquehanna	Sept. 18.	25	6—12	8	0—8	.....	....	4.8	2.7	39	Sept. 9.	27	6—7	19	2—14	9	1—0	3.8	2.4	58
Stevens' Rareripe	" 28.	69	12—3	364	44—8	41	3—1	2.8	1.9	684	" 28.	84	14—4	460	56—10	55	3—13	2.7	2.0	744
Alberta	" 9.	209	46—13	88	18—11	12	1—7	3.6	2.5	702	" 7.	290	58—9	186	26—9	56	5—4	3.2	2.8	757
Crawford's Late	" 8.	82	15—15	185	28—15	84	6—8	3.1	2.1	125	" 9.	82	5—8	170	20—8	78	5—10	2.6	1.9	21
Reeves' Favorite	" 5.	65	16—4	15	2—7	5	0—10	4.0	2.6	22	" 8.	100	25—12	30	4—12	11	1—2	4.1	2.6	31
Old Mixon	" 9.	410	56—15	419	54—6	66	5—0	2.2	2.1	689	" 9.	159	28—11	397	50—6	90	7—1	2.9	2.0	1,078
Total	....	860	154—14	1,074	189—7	202	16—5	2.9	2.1	2,261	....	692	138—14	1,262	161—11	299	23—14	3.2	2.0	2,684
Total for 1899	....	302	69—5	376	62—7	71	7—5	.....	.....	249	....	173	47—13	315	55—11	75	8—4	.....	.....	207
Total for 1900	....	1,841	205—0	1,675	184—9	315	21—10	.....	.....	998	....	1,021	186—5	1,862	216—15	441	32—1	.....	.....	1,055
Total, excluding Stevens' Rareripe	....	791	142—11	710	94—15	161	13—4	2.9	2.1	1,577	....	608	124—10	802	105—1	244	20—1	3.8	2.1	1,940
Total for 1899	....	250	57—1	224	38—0	51	5—5	.....	.....	157	....	186	37—6	179	31—8	55	6—0	.....	.....	155
Total for 1900	....	1,033	149—6	927	99—7	210	18—14	.....	.....	514	....	834	149—11	1,099	126—8	334	24—2	.....	.....	623

TABLE 18—Continued.

Peaches—Fertilizer Plots.

VARIETY.	PLOT 4. Tree 1. Date first picking.	Tree 1. Total yield. No. 1 fruits.	Tree 1. Total yield. Weight.	Tree 1. Total yield. No. 2 fruits.	Tree 1. Total yield. Weight.	Tree 1. Total yield. Culls, No.	Tree 1. Total yield. Weight.	Tree 1. Average size Nos 1 and 2, respectively.		Tree 1. No. removed in thinning.	Tree 2. Date first picking.	Tree 2. Total yield. No. 1 fruits.	Tree 2. Total yield. Weight.	Tree 2. Total yield. No. 2 fruits.	Tree 2. Total yield. Weight.	Tree 2. Total yield. Culls, No.	Tree 2. Total yield. Weight.	Tree 2. Average size Nos. 1 and 2, respectively.		Tree 2. No. removed in thinning.
			lbs. oz.		lbs. oz.		lbs. oz.	oz.					lbs. oz.		lbs oz.		lbs. oz.	oz.		
Susquehanna	Sept. 9.	27	6—13	5	0—12	2	0—3	4.0	2.4	61	Sept. 18.	2	0—7	2	0—5	.....	....	3.5	2.5	....
Stevens' Rareripe.....	....	....	....	....	....	.....	....	......	......	....	....	....	....	....	....	.....	....	......	...	....
Elberta	" 7.	376	87—2	71	10—11	11	1—3	3.7	2.4	958	" 7.	266	58—2	96	14—10	14	1—8	3.5	2.4	430
Crawford's Late.......	" 16.	219	46—2	76	11—4	26	3—2	3.4	2.4	118	" 16.	160	36—9	46	6—10	12	1—8	3.7	2.8	211
Reeves' Favorite	" 5.	38	10—8	9	1—9	1	0—1	4.3	2.8	19	" 5.	51	13—14	8	1—7	1	0—2	4.4	2.9	80
Old Mixon................	" 9.	205	39—1	278	37—2	73	6—4	3.0	2.1	429	" 9.	192	86—14	394	52—0	81	6—14	3.1	2.1	493
Total, excluding Stevens' Rareripe..........	....	865	189—5	439	61—6	112	10—13	3.5	2.2	1,580	....	671	145—14	546	75—0	108	10—0	3.5	2.2	1,166
Total for 1899......	....	179	46—1	91	14—15	23	2—10	......	......	60	....	196	52—13	159	27—8	31	8—10	......	......	101
Total for 1900.....	....	1,130	198—1	574	64—4	146	11—5	... ..	......	589	....	921	180—15	750	93—1	148	12—6	......	......	566

peration quite thoroughly performed the last of ield this year was sorted into firsts, seconds and given in the table. In order to present the totals s crops more easily, they were divided into firsts, in the same ratio as was given this season. The y can be compared in using the first totals given. —excluding Stevens' Rareripe—are to be used in plots.

detailed records reveals many interesting points in nt growth and productiveness. Thus, the average sorted into firsts and seconds from trees of the dif- ge and average as follows :

Firsts.		Seconds	
2 oz. to 4.3 oz.	av. 3.76 oz.	2.2 oz. to 2.7 oz.	av. 2 46 oz.
5 " " 2.8 "	" 2.66 "	1.3 " " 2.0 "	" 1 77 "
3 " " 3.8 "	" 3.34 "	2.2 " " 2.7 "	" 2.38 "
3 " " 3.7 "	" 3.08 "	1.9 " " 2 4 "	" 2.18 "
5 " " 4.4 "	" 3.29 "	2.2 " " 2.9 "	" 2.24 "
2 " " 3.2 "	" 2.80 "	1.9 " " 2.2 "	" 2.06 "

es the largest fruits, with Elberta second in size ripe smallest in average weight. The Elberta is roductive sorts and quite uniform. On tree 1, per cent. of the fruit by weight, sorted as No. 1, e in plot 4, almost 88 per cent. graded first. In ke the second tree in plot 2, which has only 38.4 hen in the total yields we have from one Elberta fruit, and only 47 pounds 9 ounces from another. are to be noted in all the varieties.

rieties together, taking the totals of the six first nd six trees in each plot, we have the following case of first and second-grade fruit :

	First Trees.		Second Trees	
	Firsts. Per cent.	Seconds. Per cent.	Firsts. Per cent.	Seconds. Per cent.
pe, included........	59.2	36.1	41.2	51.7
"	53.8	41.2	40.6	53.3
"	49.8	44.9	42.8	49.8
excluded	68.9	27.6	44.3	48.0
"	55.1	40.3	45.2	48.6
"	56.9	37.8	49.9	42.1
"	72.4	23.5	63.2	32 5

In the first six trees of all the plots, 50 per cent. or more of the frui grade as firsts. On the second six trees the greater part of the frui grades as seconds. Only on plots 3 and 4, Stevens' Rareripe excluded does the percentage of firsts exceed that of seconds, and in one plo only (plot 4) does the proportion of first-grade fruit exceed 50 pe cent.

The results by plots are better understood by examining the fol lowing table, where the yields of the twelve trees of each plot ar here combined. The records for the two previous crops are also in cluded. The general results for 1901 are the same as the average for the three crops, hence only the latter figures are considered :

TABLE 19.

Peaches—Totals of Fertilizer Plots.

	STEVENS' RARERIPE EXCLUDED					STEVENS' RARERIPE INCLUDE				
	Number fruits removed in thinning.	Number ripe fruits.	Weight ripe fruits.	Average weight per fruit.	Yield per acre, baskets.	Number fruits removed in thinning.	Number ripe fruits.	Weight ripe fruits.	Average weight per fruit.	Yield per acre,
			lbs. oz.	oz.				lbs. oz.	oz.	
Plot 1—1899	108	619	131— 9	3.40	76	212	1,024	201—14	3.15	[illegible]
1900	949	5,270	624—15	1.90	361	1,941	8,311	857—14	1.65	[illegible]
1901	3,338	3,262	532— 3	2.61	307	4,133	3,958	606— 5	2.45	[illegible]
Average	1,465	3,050	429— 9	2.64	248	2,095	4,431	555—6	2.42	[illegible]
Plot 2—1899	194	901	195— 0	3.46	118	331	1,272	258—12	3.25	[illegible]
1900	1,300	5,304	581—10	1.75	336	1,929	7,758	769— 0	1.59	[illegible]
1901	2,631	2,758	412—11	2.89	238	3,056	3,152	455— 8	2.31	[illegible]
Average	1,375	2,988	396— 7	2.53	229	1,772	4,059	494— 7	2.38	[illegible]
Plot 3—1899	312	895	175— 4	3.13	101	456	1,312	250—13	3.06	[illegible]
1900	1,137	4,437	562—11	2.03	325	2,053	6,655	846— 8	2.04	[illegible]
1901	3,517	3,316	500—10	2.42	289	4,945	4,389	635— 1	2.32	[illegible]
Average	1,655	2,883	412—14	2.53	238	2,485	4,119	577— 7	2.47	[illegible]
Plot 4—1899	161	679	147— 4	3.47	85	....	....	....	.....	.....
1900	1,095	3,669	560— 0	2.66	323	....	....	....	.....	.....
1901	2,746	2,741	492— 6	2.88	284	....	....	....	.....	.....
Average	1,334	2,363	399—14	3.00	231	....	....	....	.....	.....

ree plots, with Stevens' Rareripe included, plot
da added to the general fertilizer, has given the
uit, but the average size of the fruit is the least
The blank plot (No. 1) is second in yield and
it per fruit. Comparing the four plots, Stevens'
he blank plot has given the greatest yield, but
lot is second in average size. Plot 3 gives the
, with plot 4 third. Plot 4 has, however, the
it per fruit.

PEACHES—VARIETIES.

he only sort this year failing completely. In
yields of the different varieties for the year, and
s the average of the three crops and the average
ame.

TABLE 20.

Peaches—Varieties.

VARIETY.	Date first picking.	TREE 1.						TREE 2.						AVERAGE OF THREE CROPS, '99, '00, '01.	
		No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	No. 1 fruits.	Weight.	No. 2 fruits.	Weight.	Culls, No.	Weight.	Total weight.	Average per fruit.
			lbs. oz.		lbs oz.		lbs. oz.		lbs oz		lbs. oz.		lbs oz	lbs. oz.	oz.
Triumph	Aug. 1.	48	8—10	140	14— 8	45	8— 5	70	18— 7	146	18— 8	8	0—12	58— 7	1.45
Wonderful	Sept. 28.	41	8— 0	79	10— 0	7	0—12	1	0— 8	57	6— 8	29	1—15	82—12	2.67
Ward's Late White	" 28.	7	1— 1	5	0—11	2	0— 2	108	18— 7	318	40— 1	22	1—12	189— 7	1.98
Champion	Aug. 28.	286	54— 1	151	28—18	22	1—15	195	40— 5	219	82—18	78	7— 2	178— 9	2.77
Butler's Late	....	....	....	....	....	....	....	....	....	....	....	....	....	*57— 5	1.82
Surpasse	Aug. 28.	102	22—15	105	15— 8	16	1— 9	80	16— 6	129	18— 2	85	2—15	†65— 9	2.67
Sneed	July 20.	....	....	199	21—11	....	....	....	....	146	18—12	....	....	†28— 9	1.68
Crosby	Sept. 9.	91	17— 4	184	18— 1	88	8—15	167	31— 0	297	40—11	67	6— 4	127— 7	2.49

*One tree and two crops only. †Two crops only.

PEACHES.

w Method of Setting.
erate Thinning.

s experiment, together with the yield in the first the report for 1900. The records for the year, tals of 1900, are given in Table 21.

TABLE 21.

ch—a. The Usual or Stringfellow Method of ees. b. Severe vs. Moderate Thinning.

AS USUALLY SET.						STRINGFELLOW PLAN.			
Calculated to leave on tree.	Number ripe fruits picked.	Weight ripe fruit.	Average size per fruit.	Per cent. sorting as No. 1 in weight.	Average size No. 1 fruits.	Number removed in thinning.	Number ripe fruits picked.	Weight ripe fruits.	Average size per fruit.
		lbs. oz.	oz.		oz.			lbs. oz.	oz.
290	184	28— 9	3.41	74.84	3.72	485	52	10— 8	3.75
500	269	56— 1	3.33	72.58	3.90	664	388	78—11	3.04
700	357	60— 8	2.68	57.11	3.25	....	....	....	....
....	760	144—13	....	....	....	1,099	440	88—14	....
....	1,376	267— 8	....	....	....	508	1,048	208—11	....

tringfellow's method died during the summer. llow's set, is small, and only tree No. 2 com- se set as is usually done. The yield of this tree uplicate as usually set, but the number removed as against 838. Taken as a whole, the String- en yields much below that of those set as usual. lts attending severe *vs.* moderate thinning last nuance of this work this year. Column 2 of the ber calculated to be left on each of the three trees these being quite uniform in size and growth.

The extremely wet July and August caused many of the frui particularly on the tree most severely thinned, to crack badly a drop. In reality, we secured on trees 2 and 3 very nearly what aimed at on 1 and 2. First, it is interesting to compare the total of this year with the number left on the tree last year, as follows:

	Tree 1.	Tree 2.	Tree 3.
Removed in thinning, 1900...	599 fruits.	272 fruits.	216 fruits.
Picked ripe in 1900............	263 "	580 "	533 "
Total set, 1901...................	1,964 "	1,338 "	1,444 "

Comparing, as noted above, trees 2 and 3, No. 2 gave 56 pound ounce of fruit, of which 72.58 per cent., approximately 1.56 baske graded as number 1, with an average weight of 3.9 ounces. T No. 3 gave a total of 60 pounds 3 ounces, of which only 57.11 p cent., 1.32 baskets, graded as number 1, with an average weight only 3.25 ounces. Taking the total yields of these trees, that of N 2 averaged 3.33 ounces, and that of No. 3 only 2.68 ounces per fru

While the market value was not definitely determined, it is r difficult to judge as to which tree gave the most profit, particula with only 4 pounds difference in total yields, but a difference in s of nearly two-thirds of an ounce per fruit.

BUSH FRUITS—NEW VARIETIES AND SUB-IRRIGATION.

When laying out the experimental work in the spring of 1896 small plot of ground was set aside for the testing of a few of t newer sorts of the bush fruits, and also to study the effect of su irrigation for these fruits under field conditions. The fruits th provided for have been pruned, fertilized and cultivated along wi the various fruits in the permanent plots, though it is doubtful the general conditions have been quite as favorable to plant grow as in the latter case. Records have been made each season of t yields, etc., of the different varieties as demanded, and the resu are given to date in table 22. Yields are also included from simil areas of standard or similar varieties for comparison.

TABLE 22.

Novelties—Newer Varieties.

RIETY.	Yield of 1898.	Yield of 1899.	Yield of 1900.	Yield of 1901.	The four years' totals combined.
	oz.	oz.	oz.	oz.	oz.
	46.5	69.0	56.5	42.0	214.0
	11.0	68.0	140.0	282.0	451.0
	63.5	98.0	118.0	151.0	430.5
	31.0	....	....	18.0	49.0
	82.0	215.0	171.5	119.5	588.0
	25.5	....	86.0	83.0	194.5
	....	....	214.5	252.5	467.0
	....	....	421.5	132.0	553.5
	9.5	50.5	108.0	44.5	212.5
	9 5	56.5	64.0	196.5	326.5
	49.0	45.5	305.6	....	400.0
	78.0	317.5	651.5	....	1,047.0

NOTES.

erry.—A purple cap berry, hardy and vigorous. ne to the fact of only two bushes fruiting. The only on the grounds. Pronounced by the Michigan est of its kind.

ss between the Turner and Cuthbert. Plants vig- Berry large and attractive. Not equal to Cuth- productiveness. A little earlier than the latter in

a very little latter than Marlboro. Berries not size, but a bright, attractive red. Plants vigorous ive.

e fruit is bright red and attractive, but plants are

y.—Set spring of 1897. Gave a little fruit in 1898, in 1900 and 1901 gave a fair amount of fine fruit.

Allen Blackberry.—Set in spring of 1898. A seedling of Ear vest and rather superior to it. The yields of Early Harvest are from plants four years' set.

White Imperial Currant.—An excellent white sort, fruit m and good. Vigorous and quite productive. Not superior to Grape.

Red Jacket Gooseberry.—A new sort of American origin. Re Downing. Larger, but not as productive. Fruit reddish g color.

SUB-IRRIGATION FOR BUSH FRUITS.

In preparation for sub-watering, or irrigation, a deep was turned in line of the row to be, and on the bottom of the two-inch round tile was laid, end to end. The last tile at th end came to the surface to admit water from a hose into the tile. Plants of three varieties of raspberries, four of curra two of gooseberries were set in place as the furrow was filled the soil thoroughly firmed. The general care was the same a other fruits, with the addition of water into the tile under t twice in 1896, three times in 1897 and 1898, once in 1899, 1900, and once in 1901. The amount of water given range .75 inch to 3 inches, the average application being 1.46 The results are given in table 23. The figures in the last are added for comparison and are obtained by adding the y of the four unirrigated plots of the same varieties and redu equal areas.

TABLE 23.

b-Irrigation for Small Fruits.

	Yield of 1898.	Yield of 1899.	Yield of 1900.	Yield of 1901.	The four years' totals combined.	FOUR YEARS' TOTALS FROM EQUAL AREAS. Averaged from all the unirrigated plots.
	oz.	oz.	oz.	oz.	oz.	
....	6.5	131.5	157.0	146.0	441 0	454.5
....	15.5	171.0	337.5	282.0	806.0	1,299.5
....	14.5	96.5	180.5	224.0	515.5	791.0
....	5.0	63.0	50.0	133.0	251.0	328.0
....	74.0	47.0	320.0	....	441.0	1,017.0
....	44.0	173.5	320.0	....	537.5	372.5
....	33.5	121.0	184.0	176.5	515.0	588.0
....	84.5	149.0	182.0	24.5	440.0	219.5
....	28.5	26.5	140.0	200.0	395.0	497.0

cases only (Triumph gooseberry and Marlboro yield that obtained upon the unirrigated lots. eeping the line of tile open and free are too great f tile for sub-irrigation practicable. Mice and xcellent shelter.

VEGETABLES.

e tests of varieties of beans, peas and tomatoes newer sorts of these vegetables offered by seeds- wn each season, together with a few of the old nparison.

ls were as follows for the four growing months:

	1899.	1900.	1901.
....	2.04	5.58	5.01
....	3.54	2.64	0.81
....	6.32	6.94	9.12
....	3.45	2.24	8.90
....	3.84	4.35	5.96

The rainfall of 1899 and 1900 was fairly well distributed, but
1901 the spring was cold and the month of June very dry.

BEANS—VARIETIES.

Fourteen varieties were grown and records made each year. Tab 24 contains the average of these records, covering in all cases tw and in several cases three seasons' work.

Fillbasket Wax (Thorburn) is the earliest maturing sort, wit Bountiful and Stringless Green Pod second, early. Of the gree sorts, Vienna Forcer has given the largest proportion of the tot yield in the first picking. Second in this respect, and but litt difference between them, are Bountiful, Stringless Green Pod an Giant Stringless Green Pod. Scarlet Wax and the old Improve Golden Wax give the greatest proportion of total yield in first pick ing of the wax sorts.

Jones' Stringless Wax is the the most productive sort. Scarl Wax is second of the yellow-podded varieties. Of the green-podde sorts, Stringless Green Pod leads, with Giant Stringless and First i Market the same, and second in yield. Crystal White Wax is desirable new variety. One of the most productive of rather shor roundish, thick, meaty pods, greenish white in color and stringles

For three seasons, a comparison of the bush and pole lima bean has been made, using the Large White pole and Burpee's bush an Dreer's Improved pole and Dreer's bush limas. The seed wa planted in proper season, in fairly rich soil and treated the same except providing a trellis for the pole sorts, as follows: Two wire are stretched over the row, one near the ground and the other abou four feet above the first. A loose hemp cord is stretched betwee these wires by passing over and under, thus forming a fair trellis, t which the pole sorts attach themselves.

Table 25 contains the averages of the three seasons' work.

VARIETY.	Seedsman…	Days to m… able mat…	Amount … picking.	Total yiel…	Yield per…	Weight p…	Length o…	Color.	Shape of …
			oz.	oz.	oz.	oz.	in.		
Bountiful	Henderson	56	17.0	36.5	.50	.67	5.0	Light green.	Flat, thick.
Everbearing	Burpee	64	8.7	24.0	.58	.78	4.5	Green.	Flat, thin.
Stringless Green Pod	Burpee	56	15.5	33.8	.79	.98	4.5	Light green.	Round.
Earliest Red Valentine	Henderson	57	12.0	34.2	.50	.55	4.0	Green.	Round.
Crystal White Wax	Burpee	61	15.0	28.0	.68	.55	3.0	Whitish green.	Roundish thick.
Vienna Forcer	Thorburn	60	17.3	22.0	.41	.52	5.0	Green.	Flat, thick.
Dwarf Chocolate	Thorburn	60	8.8	28.8	.26	.45	5.0	Dark green.	Flat, thin.
Giant Stringless Green Pod	Burpee	60	18.0	28.5	.65	.97	5.0	Green.	Round.
First in Market	Landreth	60	9.8	28.0	.65	.84	4.5	Green.	Flat, thin.
Improved Golden Wax	Burpee	60	15.5	21.3	.86	.58	4.0	Yellow.	Flat, thick.
Fillbasket Wax	Thorburn	53	2.3	10.3	.18	.70	3.5	Yellow.	Round.
Victoria Dwarf Flageolet	Thorburn	60	4.3	24.3	.36	1.33	5.0	Green.	Flat.
Jones' Stringless Wax	Thorburn	60	8.0	24.8	1.00	1.18	3.0	Yellow.	Round.
Scarlet Wax	Landreth	60	22.3	27.3	.52	.53	5.0	Yellow.	Flat, thick.

TABLE 25.

Lima Beans—Bush vs. Pole Varieties.

VARIETY.	Date first edible pods.	Amount of first picking.	Total yield.	Number vines.	Yield per vine.
		lbs. oz.	lbs. oz.		oz.
Burpee's Bush, Burpee	Sept. 1.	4— 8	12—13	165	1.40
Dreer's Bush, Dreer	Aug. 29.	3— 3	11—10	193	1.14
Large White Pole, Burpee	Sept. 1.	7—14	20—14	100	1.87
Dreer's Imported Pole, Dreer	" 1.	5— 0	10— 2	73	1.97

There has not been much difference in earliness of maturing, but quite a little difference in amounts yielded in these first pickings. The pole sorts are by far the most productice. The great value of the bush sorts lies in avoiding the necessity of securing and setting a trellis or poles. Also allows of rather closer planting.

PEAS—VARIETIES.

Twenty-nine varieties have been grown and records made each season. Table 26 contains the averages of these records.

TABLE 26.

Peas—Varieties.

	Seedsman.	Days to marketable maturity.	Amount of first picking.	Total yield.	Yield per vine.	Weight per vine.	Per cent. edible.	No peas per pod
			oz.	oz.	oz.	oz.		
	Johnson & Stokes	52	6.8	9.2	.17	.12	46	4.9
	Burpee	52	4.7	7.0	.12	.87	46	4.8
	Thorburn	52	4.2	5.0	.21	.88	50	4.8
	Dreer	52	6.8	7.8	.16	.07	49	4.8
	Dreer	52	7.0	9.2	.10	.08	46	4.4
	Dreer	57	5.8	5.8	.41	.26	88	8.7
	Burpee	57	6.5	7.2	.50	.25	50	4.2
	Burpee	67	8.8	8.8	.18	.66	......	......
	Johnson & Stokes	52	7.0	8.5	.18	.12	47	4.5
ke	Henderson	52	7.0	8.5	.15	.08	48	4.8
	Johnson & Stokes	67	7.0	7.8	.49	.25	49	4.4
	Burpee	67	6.8	7.5	.21	.21	56	8.8
	Burpee	67	4.2	4.8	.12	.58	46	4.5
	Henderson	67	4.7	6.5	.28	.44	57	5.7
	Burpee	67	1.8	4.8	.85	.59	......	......
	Dreer	67	8.2	4.2	.20	.47	......	......
	Henderson	57	4.7	5.0	.16	.12	44	8.8
	Burpee	57	5.0	5.8	.18	.15	88	8.5
	Henderson	67	1.2	4.5	.82	.49	47	6.5
	Burpee	67	4.7	8.2	.17	.25	50	6.2
	Burpee	67	1.8	7.8	.28	.68	45	8.9
	Burpee	67	4.7	8.2	.27	.40	48	6.9
	Burpee	67	4 7	6.5	.22	.86	45	5.2
	Dreer	67	6.7	8.8	.89	.50	45	6.8
	Burpee	67	2.7	8.8	.41	1.04	......	......
Market	Burpee	67	6.8	9.2	.20	.88	48	6.8
	Landreth	66	7.8	8.8	.09	.14	48	6.4
	Landreth	58	10.5	10.8	.16	.07	48	4.9
	Maule	60	10.8	11.8	.27	.21	51	4.2

Of the early smooth sorts, none are superior to the Alaska, standard of this class. Extra Early Pioneer is a close second, like wise an old standard. Nott's Excelsior, of the early wrinkle varieties, is not as productive as usual. Surprise is one of th earliest and most productive of this class. Premium Gem mature five days later and yields over twice as much per vine. Under th conditions of the test, the earlier sorts have given the best result Premium Gem is the most productive sort, with Advancer maturin ten days later, giving very nearly as large returns. Nott's New Pe fection is a desirable newer sort—a little later and a little talle growing than Nott's Excelsior.

Considering the next to last column of table, the per cent. of tota weight that is edible, the range is from 33 per cent. in Ameer to 5 per cent. in Admiral—a difference of considerable importance to th consumer. Next to Admiral, the varieties giving the largest pe cents. edible and in order are: Quality, 56; Nott's New Perfec tion, 51; Surprise, Premium Gem and Heroine, 50 each; Advanc and Extra Early Pioneer, 49 each.

The medium early, wrinkled sorts, planted to give a succession have proven the most satisfactory.

TOMATOES—VARIETIES.

Twenty-nine varieties have been grown. Seeds of these sort were started in the forcing-house about the middle of March, handled twice in pots and set in the field May 15th to 20th, varying with the season. Four plants of each variety were used in a test. Good fiel culture was given and records made as required in all cases. Tabl 27 contains the averages of the yearly records, and shows quit plainly the results of the comparisons.

	Seedsma	Days to r	Number.	Weight.	Number.	Weight.	Average	Number.	Weight.	Per cent.	Number.	Weight.	Per cent	Color of
				lbs. oz.		lbs. oz.	oz.		lbs. oz			lbs. oz.		
Aristocrat	Henderson	71	20	5—6	76	17—15	3.8	39	5—2	22.9	7	1—2	4.5	B. red.
Beauty	Burpee	67	23	7—10	101	32—8	5.3	36	6—10	15.0	6	1—9	3.7	Pink.
Best of All	Livingston	74	14	5—13	137	45—8	5.5	18	2—5	4.9	8	2—2	4.3	Red.
Combination	Burpee	70	19	6—0	107	32—2	4.9	32	5—12	14.6	9	1—15	5.4	Red
Dwarf Golden Champion	Burpee	73	9	2—5	57	13—13	4.0	36	5—3	25.2	8	1—6	6.8	Yellow.
Earliest	Maule	77	35	10—0	97	27—14	4.7	39	5—8	14.0	24	4—10	12.3	Red.
Early Bird	Johnson & Stokes	66	37	7—4	76	11—7	2.6	154	17—0	58.4	25	3—4	9.0	Pink.
Early Dwarf Prolific	Burpee	77	22	3—13	44	7—10	2.8	269	23—3	76.8	19	1—14	6.2	Red.
Early Ruby	Henderson	64	27	7—9	97	25—11	4.2	36	5—9	23.0	16	3—8	8.6	Red.
Enormous	Burpee	79	12	6—8	64	30—15	7.9	36	3—6	7.7	18	4—8	10.2	Red.
Early Richmond	Landreth	77	46	12—6	119	28—5	3.8	54	8—6	17.6	10	1—15	5.6	Red.
Fordhook Fancy	Burpee	67	10	2—6	58	13—6	3.7	52	6—15	33.9	9	1—9	8.0	Pink.
Fordhook First	Burpee	67	23	6—4	89	23—13	4.3	40	6—15	23.5	14	2—11	7.6	Pink.
Freedom	Henderson	69	21	4—12	84	20—0	3.8	73	8—12	30.7	12	2—0	6.3	B. red.
Honor Bright	Burpee	74	14	4—7	78	21—5	4.5	32	4—10	14.9	14	3—3	11.7	Red.
Hulsart's Selection	Hulsart	60	40	13—0	114	31—15	4.6	28	4—11	12.6	20	4—0	9 1	Red.
Kansas Standard	Kansas Seed House	76	12	3—15	96	29—5	4 9	18	3—4	11.0	9	1—5	4.6	Red.
Magnus	Vaughan	80	11	4—3	117	37—3	5.2	26	5—13	10.8	12	3—11	7.4	Pink.

TABLE 27—Continued.

Tomatoes—Varieties.

VARIETY.	Seedsman.	Days to ripe fruits.	EARLY YIELD.		TOTAL MARKETABLE FRUITS.			CULLS.			ROTTEN.			Color of fruits.
			Number.	Weight.	Number.	Weight.	Average per fruit.	Number.	Weight.	Per cent. of total.	Number.	Weight.	Per cent. of total.	
				lbs. oz.		lbs. oz.	oz.		lbs. oz.			lbs. oz.		
Matchless	Burpee	77	10	4— 8	114	39— 2	5.5	15	2— 5	6.4	8	2— 5	4.4	Red.
Money Maker	Johnson & Stokes	70	15	4— 4	95	24—15	4.8	32	4—14	19.0	18	2—11	8.2	Pink.
Optimus	Dreer	78	14	4— 8	121	35—10	4.8	25	4— 0	10.9	12	2— 9	5.9	Red.
Perfection	Livingston	67	17	5—10	96	30— 5	4.9	30	5— 0	16.4	10	2— 7	6.4	Red.
Quarter Century	Burpee	77	16	5— 5	86	28— 4	4.8	19	3— 2	10.4	14	2—14	8.4	Red.
Rosalind	Thorburn	77	5	1—12	75	28— 0	6.2	19	4— 3	10.6	5	1— 4	4.4	Pink.
Success	Maule	85	16	5—14	132	19—11	4.2	31	4— 7	10.0	14	2—15	6.9	Red.
Truckers' Favorite	Burpee	69	13	6— 8	128	39— 2	5.0	34	5— 5	11.8	13	3— 0	6.4	Pink.
T. T. T.	Landreth	69	36	10—13	140	42— 5	4.9	43	5—11	11.2	11	2—11	5.8	Red.
Virginia Corker	Landreth	79	23	8— 2	169	48—11	4.6	27	4— 6	7.1	8	1—14	3.2	Red.
White's Excelsior	Maule	80	24	8— 7	131	38— 2	4.7	38	5—11	11.7	19	4— 9	9.5	Pink.

maturing the variety termed Hulsart's Selection s any other sort. This is a variety developed by C. C. Hulsart, the well-known grower of tomatoes nty. In growth it resembles the Early Ruby, but of marketable fruit it averages .4 ounces larger per s rough and irregular as the Ruby.

is rather arbitrarily set, but includes the first half The variety Hulsart's Selection exceeds in early nond, the next in order, by $2\frac{1}{2}$ ounces per plant, T. 9 ounces per plant, and Earliest by 12 ounces per four varieties in order of early yield are White's a Corker, Beauty and Early Ruby. In total yield it Virginia Corker leads, with Best of All second. ss, Truckers' Favorite, White's Excelsior, Magnus, Combination, Hulsart's Selection and Enormous, in order of yield of marketable fruit. Enormous verage weight per fruit, 7.9 ounces. Others having are Rosalind, 6.2 ounces; Best of All, 5.5 ounces; nces; Beauty, 5.3 ounces; Magnus, 5.2 ounces, orite, 5 ounces.

rds, the proportion of culls and of rotten fruit was ained. In the proper columns in the table the ghts of tomatoes grading as culls and rotten are ing each is the percentage each is of the total yield Best of All shows the smallest per cent. of culls and west per cent. of rotten fruit. Matchless, Virginia nous are other varieties having small percentage of her hand, over three-fourths of the total yield of fic graded as culls, and in Early Bird 53.4 per cent. inia Corker gave the lowest percentage of rotten next in order; then follows Best of All, Match- Earliest and Honor Bright show the largest per- ruit.

TOMATOES—LARGE VS. SMALL SEED.

In the last vegetable report,* we noticed the beneficial effect using the first plants to appear in the seed plot in comparison wi those germinating more slowly—three days' difference. Continui the study further, 50 of the largest and 50 of the smallest, yet wel formed seed of the Beauty variety, were selected. These we plant in plots in the forcing-house, and from two to three days differen was noted in the germination, the larger ones appearing first. T treatment thereafter was identical. Table 28 contains the averag of three seasons' records. The last column contains the weight the 50 seeds planted in each case.

TABLE 28.

Tomatoes—Large vs. Small Seed.

BEAUTY	Days to first ripe fruit.	EARLY YIELD.		TOTAL MARKETABLE FRUIT.			CULLS.			ROTTEN.			Weight of 50 seeds planted
		Number.	Weight.	Number.	Weight.	Average per fruit.	Number.	Weight.	Per cent. of total.	Number.	Weight.	Per cent. of total.	
			lbs. oz.		lbs. oz.	oz.		lbs. oz.			lbs. oz.		gr
Large Seed......	73	24	7—15	103	29—15	4.6	33	6—14	17.1	12	2—12	6.4	.
Small Seed......	69	18	5— 7	97	29— 8	4.9	88	6— 6	18.2	9	1—13	4.7	.

The small seed gave ripe fruit four days earlier, but in the ear yield the plants from the large seed gave 10 ounces per plant mo than was obtained from the small seed plants. In total yields slight difference exists in favor of the use of large seed. The plan from large seed yielded a smaller percentage of culls but a larg percentage of rotten fruits. The after care of the plants has more do with the yields obtained than has the selection of seed.

* Annual Report 1898, page 188.

ATOES—EARLY AND LATE STARTING.

s considered in the 1898 report,* starting the first th, and thereafter every ten days until April 7th, The results were not definite. This question of g was then continued, commencing earlier and e between starting the different lots, *i. e.*, February March 1st, March 15th and April 1st. The seed- in pots as occasion demanded, otherwise the treat- was identical. Table 29 contains the results of , as outlined.

TABLE 29.

atoes—Early and Late Starting.

RLY YIELD.		TOTAL MARKETABLE FRUIT.			CULLS.			ROTTEN.		
Weight.	Average per fruit.	Number.	Weight.	Average per fruit.	Number.	Weight.	Per cent. of total.	Number.	Weight.	Per cent. of total.
lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.			lbs. oz.	
9—4	4.9	110	32—8	4.7	56	8—9	19.4	15	3—0	6.8
9—2	5.2	116	35—8	4.9	48	7—8	16.2	15	3—8	6.9
8—7	5.0	107	32—13	4.9	42	7—5	17.8	6	1—1	2.6
6—8	5.5	89	27—5	4.9	41	6—7	18.4	6	1—5	3.7
7—12	6.2	87	29—12	5.5	24	4—13	12.9	11	2—11	7.2

shows the number of times the plants were the size of pot each time. The second column tarted February 15th and March 1st matured ime, and earlier than the other lots, dating from In early yield the first lot exceeds the second by half ounce per plant, too small an increase to be onsidering the extra cost. Considering the total

, page 185.

yield, the second lot, started February 15th, gives almost ele
ounces per plant more than any other lot. Those started March
are second in yield. The results obtained as above point to
latter half of February as the best time to start the seed, and requ
handling three or four times.

F THE ASSISTANT IN DAIRY HUSBANDRY.

DAIRY HUSBANDRY.

department during the past year has been chiefly
llowed in several previous years, the principal
ation being as follows :

age crops, including crop rotations, cost and yield
varieties.

business, including the cost of production and sale
lling and delivery.

years, daily records have been kept by the dairy
k of each animal has been analyzed weekly, the
e reported.

five years considerable time has been given to
ilk by the "Babcock" method, the number of
g to 9,000. In addition to the regular work in
ples have frequently been sent to the Station by
n and by Breeders' Associations.

new wing was built to the main dairy barn, a
h is given in this report.

ve been conducted with Oat and Pea Straw, Feed
urpose of studying their relative value and influ-
vth of animals.

Right Lap Cutaway in summer seeding was made
xperiment, the results of which are reported.

re made in growing cow peas and corn for silage,
urther study of the feeding value of this combina-

ve been conducted with seeding grass without the
. A study was also made of the relative value of
izers in the production of grass.

re made in constructing farm roads of different
g cinders, gas lime and stone lime.

ess in relation to soil exhaustion has been studied
ears, and the results showing the gains and losses
orted.

Since the last report was issued, Bulletin No. 148, "Alfalf Methods of Culture and Yields per Acre—Alfalfa Protein versus Pu chased Protein in Rations for Dairy Cows," has been publishe The bulletin included the following summary :

Summary.

1. The successful establishment of alfalfa requires :
   a. That the surface soil shall be well supplied with t mineral elements, lime, phosphoric acid and potas
   b. That during the early growth of the crop, the wee should be frequently cut.
   c. That the crops should be harvested preferably just befo the plants are in blossom.
2. The crop is well adapted for soiling and for hay. The average yie of green forage per acre for three years (including the fi year), was 18.27 tons, equivalent to 4.57 tons of hay. T yield the third year from five cuttings was 26.6 tons of gre forage, equivalent to 6.65 tons of hay, costing $3.69 per to
3. A feeding experiment showed that the protein in alfalfa hay cou be successively and profitably substituted in a ration for dai cows for that contained in wheat bran and dried brewe grains, and for this purpose is worth $11.16 per ton, wh compared with the wheat bran and dried brewers' grain $17 per ton.
4. The use of alfalfa hay reduces the necessity for the purchase protein feeds.

SOILING CROPS, 1901.

The season of 1901 was generally favorable for the growth of fora crops. With the exception of the month of June (rainfall . inches), crops were not seriously affected by drought. Fifteen kin of forage were grown. Some new varieties tested in previous ye were given further trial. The herd, including young stock, w equivalent to fifty full-grown animals. The arrangement of fora crops, shown in Table I., furnished a continuous supply from M 1st until November 1st. About one and one-half tons of green f age were cut each morning to supply the herd for the day. T was fed to the cows in a two-acre field, where they were turn every morning for exercise. The amount of forage fed varied acco ing to the kind of fodder and the requirements of the individ

verage amount per day was practically sixty pound
ldition to the roughage used in summer, the cows
ation mixed in the following proportion :

....	4	pounds.
s' grains...	4	"
....	2	"

g to the needs of the individual animals. A careful
of the cost of producing each crop, time of cutting
the yield per acre. Data concerning crops grown in
ed in the following table :

TABLE I.

Cost and Yield of Soiling Crops.

Seed used—bushels.	Date of seeding.	COST OF— Labor.	Seed.	Fertilizers.	Period of cutting and feeding.	Yield—tons.	Total cost.
4	Sept. 27, '00	$1 20	$2 40	....	May 1- 7............	9.4	$3 60
4	Oct. 8, '00	5 00	2 40	....	" 7-19............	19.2	7 40
7/12	May 14, '98	....	....	....	" 19-25............	11.1	....
4	Sept. 26, '00	5 00	3 40	....	" 25 to June 1..	10.4	8 40
1½	July 16, '00	3 60	4 20	....	June 1-21............	42.8	7 80
....	....	....	....	....	" 21-26............	8.8	....
{ 4 / 3 }	April 2......	5 40	4 81	$4 90	" 26 to July 4..	12.4	15 11
{ 4 / 4 }	" 11......	6 00	5 96	6 86	July 4- 9............	8.2	18 82
....	....	....	....	....	" 9-11............	2.1	....
{ 10 / 7/12 }	" 19......	15 00	14 65	12 85	" 11-22............	16.4	42 50
½	May 2......	12 00	25	6 24	" 22 to Aug. 3..	17.7	18 49
1¾	June 19......	6 00	1 48	7 46	Aug. 3-19............	23.2	14 94
2	" 10......	3 00	4 50	3 38	" 19-25............	8.8	10 88
2	" 10......	3 00	3 00	3 33	" 25 to Sept. 1..	10.5	9 33
{ 2 / 1 }	July 10......	6 30	6 76	5 68	Sept. 1-16............	24.4	18 74
¼	" 11......	3 00	8 00	5 42	" 16 to Oct. 1..	20.2	16 42
1½	" 24......	4 20	2 25	1 48	Oct. 1- 5............	8.0	7 98
....	....	....	....	....	" 5-27............	20.0	....
3½	Sept. 2......	7 20	2 45	3 54	" 27 to Nov. 1..	5.2	13 19

GENERAL REMARKS CONCERNING CROPS.

Rye and Wheat.—Rye is our first forage crop, and is usually ready for cutting the first week in May. Four acres were grown for soiling this year. The yield ranged from 4.7 to 9.6 tons per acre, and averaged 7.2 tons.

Wheat follows rye very closely in the forage rotation. Two acres were grown this season. The yield was light, owing to the fodder being cut early in order to seed the land to other crops. The average yield of wheat was 5.2 tons per acre.

Alfalfa.—The acre of alfalfa sown May 14th, 1898, was cut four times this season. The yield at each cutting was as follows: May 19th, 11.14 tons; July 9th, 2.8 tons; August 11th, 1.17 tons hay, equivalent to 4.68 tons green forage; September 28th, 0.77 tons hay, equivalent to 3.08 tons green forage. The total yield for the year was 21.7 tons of green forage. The following table shows the yield of alfalfa and the cost per acre for four years:

TABLE II.

The Yield of Alfalfa and the Cost Per Acre for Four Years.

	Seed—pounds.	Date of seeding.	YIELD—TONS. Green forage.	YIELD—TONS. Equivalent to hay.	COST OF— LABOR. Seeding.	COST OF— LABOR. Harvesting.	COST OF— Seed.	COST OF— Manures and fertilizers.	Total cost.
First year	80	May 14, '98	8.00	2.00	$8 65	*$1 92	$3 15	$23 65	$37 37
Second year	.....	.....	20.21	5.05	.....	4 86	.....	20 88	25 69
Third year	.....	.....	26.60	6.65	.....	6 89	.....	18 15	24 54
Fourth year	.....	.....	21.70	5.48	.....	5 21	.....	17 75	22 96
Total	80	.....	76.51	19.18	$8 65	$18 88	$3 15	$80 88	$110 56
Average	.....	.....	19.13	4.78	.....	4 60	.....	20 10	27 64

*On hay basis.

Two more acres of alfalfa were seeded May 5th, 1900, as an experiment on land that had not received any special preparation in previous years. A fair stand was secured at the start, but weeds and grass

Fig. 1.
Showing hill of Southern White Corn, produced from one seed.

Fig. 2.
A crop of Sorghum. Yield, 14 tons per acre.

session of the ground, and it was turned under the results emphasize the fact that in order to succeed ecessary to grow a cultivated crop for several years in order to destroy the weeds.

f acres of alfalfa were also seeded this spring (1901) ble conditions. A fair stand was secured and the l, November 6th.

-This plant has proved very valuable in the forage wn in the corn in July at a small expense, and op through the winter. In the spring the clover wth and is usually ready for cutting the last week yielded 42.8 tons of forage. Crimson clover also ay. Experiments are now in progress to test its results of which will be given in future reports.

Probably no forage crop is more commonly grown oats and peas. They yield well when there is a rainfall. The drought in June retarded their The yield on four acres ranged from 4.1 to 6.2

Corn.--A valuable crop for mid-summer feeding il the first frost. In favorable seasons two crops e same area. Two acres were planted for forage ed at the rate of 9.0 tons per acre.

oy Beans.—These crops are rich in nitrogen, and resisting drought, hence they occupy an important e rotation. Cow peas usually produce a higher ans, and are more succulent. This season the anged from 8.0 to 10.5 ton, while the soy beans r acre.

—This variety has been grown on the farm for has given good results. In favorable seasons a ecured in forty days. The average yield per acre tons.

ke the barnyard millet, this crop makes a rapid well when there is an abundance of moisture. content of water, its feeding value is not as great ariety. When allowed to mature, the yield is han barnyard millet.

Owing to drought or delay in seeding, it some- gaps occur in the forage rotation for a few days. convenient to have a few acres of mixed grasses

or clover to aid in keeping up a continuous supply of fo
Animals like a change in the ration, and are very fond of this
of forage. A field of mixed grasses is shown in Fig. 3.

Barley.—This is the latest forage we feed in the fall, and
seeded in August it usually yields well, making some growth
after the weather becomes cool. The yield was low this year, f
reason that the plots were not seeded until September. Two
produced 5.2 tons.

Special Crops.

White Flint Corn.—A very desirable variety for forage, owing
suckering habit and vigorous leafy growth. Yields ranging fro
to sixteen tons per acre have been secured. Fig. 1 shows a
five stalks, produced from one seed. Four of the stalks have
developed ears.

Cow Peas and Kaffir Corn.—Two acres of this combination of
were grown this season. It is a very nutritious fodder and
relished by dairy animals. The two acres yielded 24.4 tons.

Sorghum.—This plant was grown for the first time in 189
yielded 12.8 tons per acre. It was given a further trial this se
and yielded 14.0 tons per acre. Sorghum contains a high cont
water (85.19 per cent.), and is much inferior to Indian corn in
ing value. It has one advantage, however, over many of our
crops, in that it thrives well in a dry season. The entire cro
year was put into the silo. A crop of sorghum is shown in Fig

Cow Peas and Corn as a Silage Crop.

This combination of crops was grown as an experiment, the
being (1) to see whether the two crops could be cut together
corn harvester; (2) to place the mixture in the silo and stu
keeping qualities and feeding value.

The corn (Southern White) was planted June 23d, in drills,
and one-half feet apart, the stalks standing nine inches apart
drill. After the first cultivation (July 17th), cow peas (Wond
were planted in drills as near the corn as possible, at the rate
peck per acre. Fig. 6 shows the crop just before harvesting (Se
ber 26th). Both the corn and cow peas made a vigorous growt
corn acting as a support for the peas. It is believed, however
it would be a better plan to plant the cow peas and corn at the
time. The crop was cut with a corn harvester, which boun

he corn without any difficulty. Further, no diffi-
nced in running the two crops through the silage
, and it is believed that this combination of crops
able ration for dairy animals. At this time, how-
ble to report upon its keeping qualities and feeding
ults may be expected in further reports.

The Right Lap Cutaway.

akes the place of a plow and was used in seeding
age crops this season. Fig. 7 shows the cutaway
ive turning disks, twenty-four inches in diameter,
sted to cut from three to six inches deep. Five
ne left side cut the surface soil and prepare it for
nich follow. The machine is drawn by four horses
much more rapidly than the ordinary plow. It
(1) of preparing the ground at one operation,
and expense; (2) it pulverizes the soil to such a
moisture is retained than when the ordinary plow
utaway can be used to prepare ground which has
plow, and for this reason is particularly valuable.
p of cow peas and Kaffir corn put in with this
op followed oats and peas, and yielded 12.2 tons

Seeding Grass Without Grain.

acres was seeded to grass September 20th, 1900,
s and peas had been removed. The land was pre-
g and rolling alternately until the soil was solid,
seed bed. A mixture containing the following
was used per acre: 7.5 pounds timothy, 5 pounds
alsitke clover, 5 pounds red clover and 1.5 pounds
grass. Six of the nine acres had received manure at
ons per acre, and acid phosphate at the rate of 150
at the time of seeding the oats and peas. The
cres received an application of 300 pounds of fer-
xed, in the following proportion:

ate of soda.
nd bone.
iate of potash.
phosphate.

The seed came up well, and as the conditions were favorable, gr nicely throughout the late summer and fall. The grasses show an excellent stand in the spring, but only a small percentage of t clovers survived the winter. Early in the spring the six acres, p viously treated with yard manure, received another application the rate of 5 tons per acre, while the three fertilized plots receiv 350 pounds per acre, of the following mixture:

150 pounds of ground bone.
100 " " muriate of potash.
100 " " nitrate of soda.

The crop grew remarkably well on the whole field, lodging on p tions of the fertilized plots. Cutting began June 26th, and t average yield of cured hay per acre on the manured plots was 3 tons, and on the fertilized plots 3.11 tons. A second crop was a secured in October, which was fed green to the dairy herd. Th results show that it is possible, by thoroughly preparing the soil a applying a liberal amount of either manure or fertilizer, to secure good crop of hay without a grain crop. Fig. 9 shows the hay fi at time of harvesting.

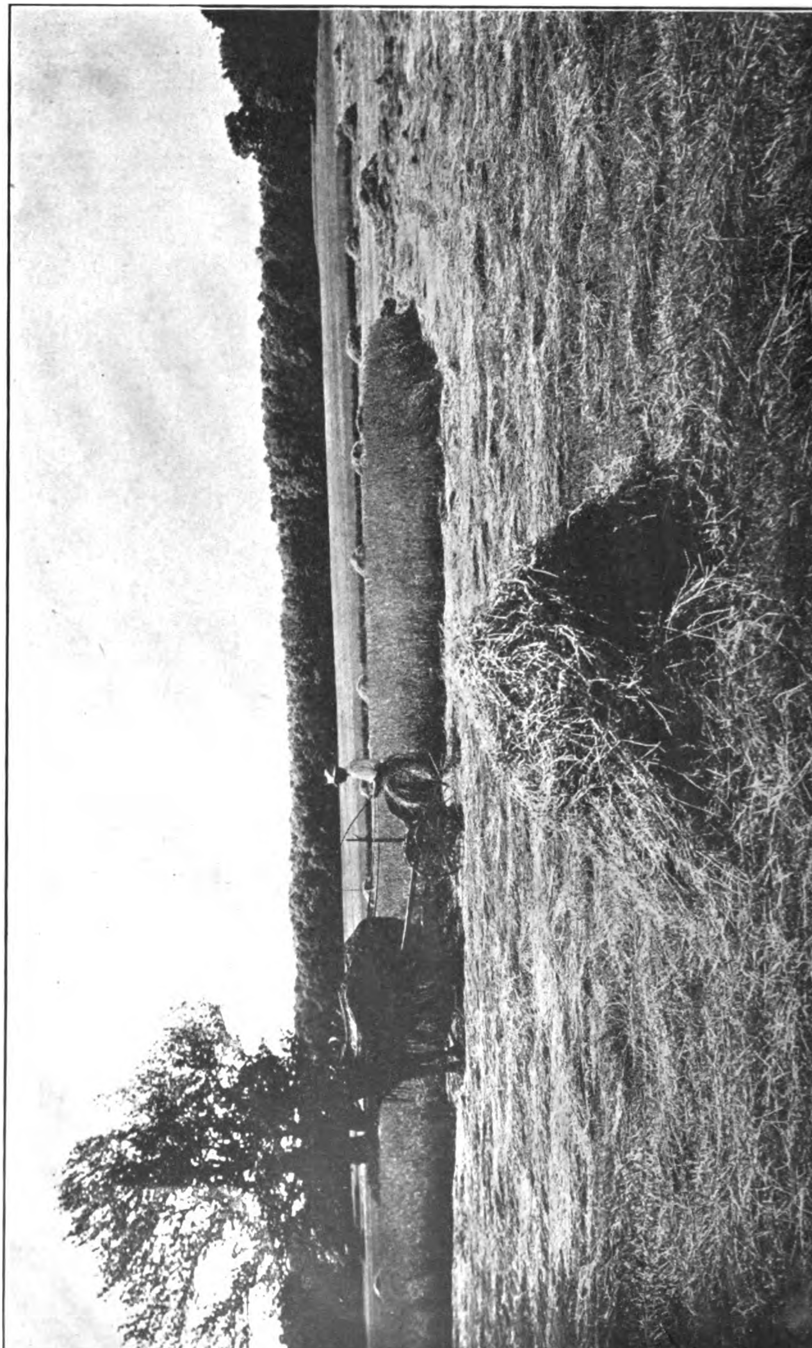
Experiment With Feeding Oat and Pea Feed and Straw ver Oat and Pea Hay.

The increase in the price of feeds commonly used in the dai naturally causes the dairyman to look about for some bye-produ in manufactories, or some food that can be produced on the farm take the place of the high-priced feeds, which in previous years has purchased at a much lower figure. There are many crops th can be produced on the farm, such as alfalfa, crimson clover, oa and peas, and cow peas, which make excellent hay. These crops a rich in nitrogen, and will, in a large measure, take the place of pu chased feeds.

The object of this experiment with Oat and Pea Feed and Stra and Oat and Pea Hay was to study the relative value of these foo and their influence upon:

I. The Yield of Milk.
II. The Composition of Milk.
III. The Economic Production of Milk and Butter.
IV. The Individual Animals.

The experiment began December 14th and continued throu January 12th—thirty days. Four cows were included in the te



s of two cows each. At the beginning of the test, the of the cows in Lot I., was 985 pounds, and in Lot II.,

The Rations Used.

A FEED AND RATION.	Dry matter.	TOTAL. Protein.	Fat.	Carbohy-drates.	Estimated nutri-tive ratio.
	lbs.	lbs.	lbs.	lbs.	
....	7.69	.51	.24	5.10	....
Pea Straw	4.72	.25	.10	4.00	....
Pea Feed..............	6.31	1.17	.27	4.54	....
eed Meal...	2.76	1.27	.38	.89	....
....	21.48	3.20	.99	14.53	1 : 5.2

Oat and Pea Hay Ration.

....	7.69	.51	.24	5.10	....
Pea Hay	13.22	1 23	.37	10.57	....
eed Meal..............	2.76	1.27	.38	.89	....
....	23 67	3.01	.99	16.56	1 : 6.0

ns contained practically the same amount of protein e dry matter and carbohydrates were slightly greater n. The nutritive ratio in the Oat and Pea Feed and estimated at 1:5.2 and 1:6.0, respectively.

I. THE YIELD OF MILK AND FAT.

n each cow was weighed daily, and sampled and ana-ek, to obtain percentage of butter fat. Table III. yield of milk and its composition, as well as the total d of fat per cow during each period of the test.

TABLE III.

Lot I.—First Period. OAT AND PEA FEED AND STRAW. **Lot II.—First Period.** OAT AND PEA HAY.

	COW NO. 1.			COW NO. 2.			COW NO. 3.			COW NO. 4	
	Milk.	Fat.	Fat.	Milk.	Fat.	Fat.	Milk.	Fat.	Fat.	Milk.	Fat.
	lbs.	p. c.	lbs.	lbs.	p. c.	lbs.	lbs	p. c.	lbs.	lbs.	p. c.
December 14...	27.9			28.8			30.5			20.4	
" 15...	29.2			30.9			31.5			19.9	
" 16...	29.6			30.0			31.[illegible]			20.7	
" 17...	30.7			33.6			32.8			20.6	
" 18...	30.0			30.7			30.1			19.0	
" 19...	30.9			31.7			31.4			18.8	
" 20...	29.4	4.3	8.93	32.6	4.6	10.02	31.4	4.6	10.04	18.6	4.1
" 21...	28.8			31.2			31.1			18.4	
" 22...	30.6			32.5			31.1			19.8	
" 23...	29.1			30.8			28.9			18.9	
" 24...	30.4			33.8			32.9			18.7	
" 25...	29.0			30.9			31.4			18.4	
" 26...	31.8			34.5			31.5			18.2	
" 27...	29.9			33.2			27.9			18.0	
" 28...	29.1	4.3	10.26	33.6	4.4	11.47	29.6	4.7	11.49	19.1	4.1
Total.......	446.4		19.19	478.4		21.49	462.6		21.53	287.5	
Average...	29.8	4.30	1.28	31.9	4.49	1.43	30.[illegible]	4.65	1.44	19.2	4.10

Lot I.—Second Period. OAT AND PEA HAY. **Lot II.—Second Period.** OAT AND PEA FEED AND STRAW.

	COW NO. 1.			COW NO. 2.			COW NO. 3.			COW NO. 4	
December 29...	29.1			30.9			31.0			19.2	
" 30...	27.8			30.4			28.8			19.9	
" 31...	27.6			32.6			31.8			20.8	
January 1...	27.8			31.0			29.9			17.7	
" 2...	27.6			31.6			30.4			21.1	
" 3...	27.6			32.5			32.3			19.0	
" 4...	25.8	4.2	8.10	33.4	4.1	9.12	33.2	4.6	9.98	19.9	4.2
" 5...	29.0			32.4			32.2			20.0	
" 6...	28.4			32.0			30.8			19.0	
" 7...	27.2			32.8			33.1			19.8	
" 8.	27.1			33.0			32.0			19.4	
" 9...	28.4			33.5			31.4			19.2	
" 10...	28.9			32.4			32.8			19.3	
" 11...	27.7			32.6			33.1			19.7	
" 12...	26.7	4.3	9.61	31.7	4.0	10.42	31.6	4.6	11.80	20.2	4.2
Total.......	416.2		17.71	482.8		19.54	473.4		21.78	293.7	
Average...	27.7	4.26	1.18	32.2	4.05	1.30	31.6	4.60	1.45	19.6	4.2

2, constituting Lot I., were fed during the first
4th to 28th, inclusive, on the Oat and Pea Feed
and cows Nos. 3 and 4 were fed during the same
and Pea Hay Ration. In order to equalize the
lactation, the rations were reversed at the end of
ecember 28th), and, beginning with December
g through January 12th, Lot I. received the Oat
ot II. the Oat and Pea Feed and Straw Ration. It
the case of Lot I. that cow No. 1 lost 2.1 pounds,
l cow No. 2 gained .3 pounds, or .009 per cent.,
the Oat and Pea Feed and Straw Ration to the
Ration. In Lot II., cow No. 3 increased in milk
of .8 pounds, or 2.6 per cent , and in case of No.
day, or 2.1 per cent., when changed from the Oat
n to the Oat and Pea Feed and Straw Ration.
shows the total yield of milk and butter fat from

TABLE IV.

Summary of the Test.

	OAT AND PEA FEED AND STRAW RATION.				OAT AND PEA HAY RATION.			
	Milk.	Fat.	Fat.	Butter.	Milk.	Fat.	Fat.	Butter.
	lbs.	p. c.	lbs.	lbs.	lbs.	p. c.	lbs.	lbs.
	446.4	4.30	19.19	22.39	416.2	4.26	17.71	20.66
.	478.4	4.49	21.49	25.07	482.8	4.05	19.54	22.80
.	473.4	4.60	21.78	25.41	462.6	4.65	21.53	25.12
.	293.7	4.20	12.32	14.37	287.5	4.10	11.79	13.75
.	1,691.9	4.42	74.78	87.24	1,649.1	4.28	70.57	82.33

shows that 42.8 pounds, or 2.6 per cent. more
nds, or 5.96 per cent. more fat, were produced
ea Feed Ration than from the Oat and Pea Hay

II. THE COMPOSITION OF THE MILK.

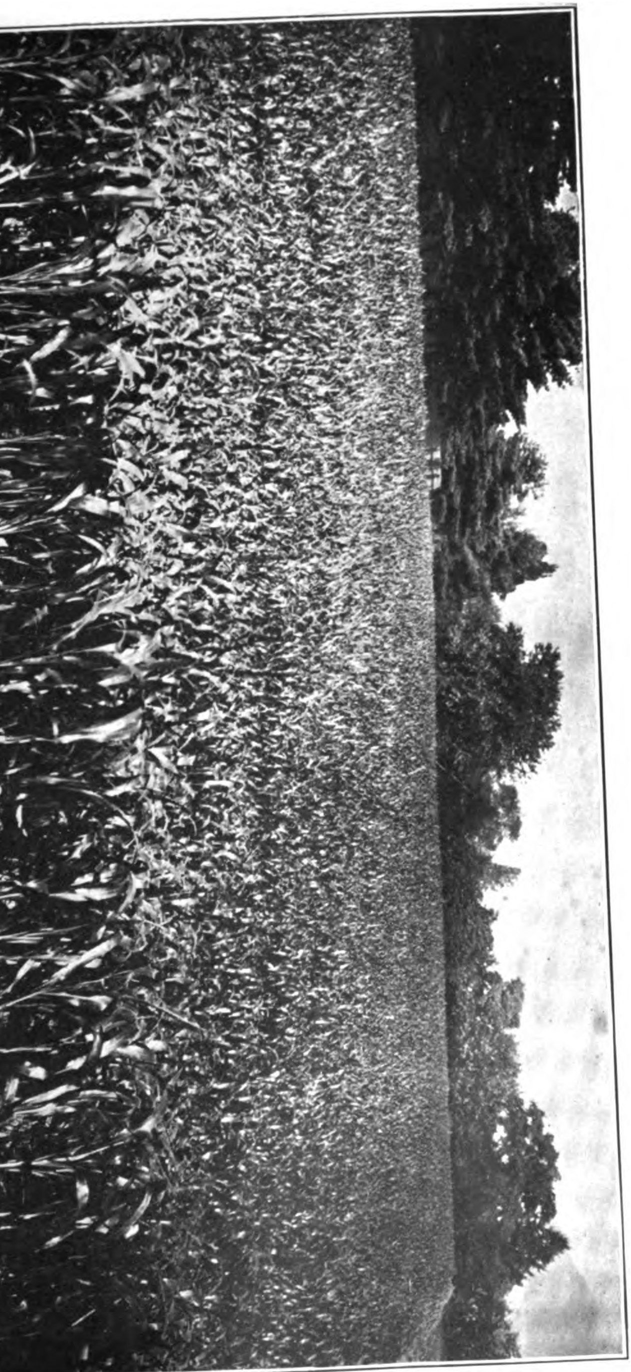
A study of the summary indicates that the composition of milk was not materially influenced when the cows were chan from the Oat and Pea Feed Ration to the Hay Ration, or the rever The following tabulation will show this more clearly :

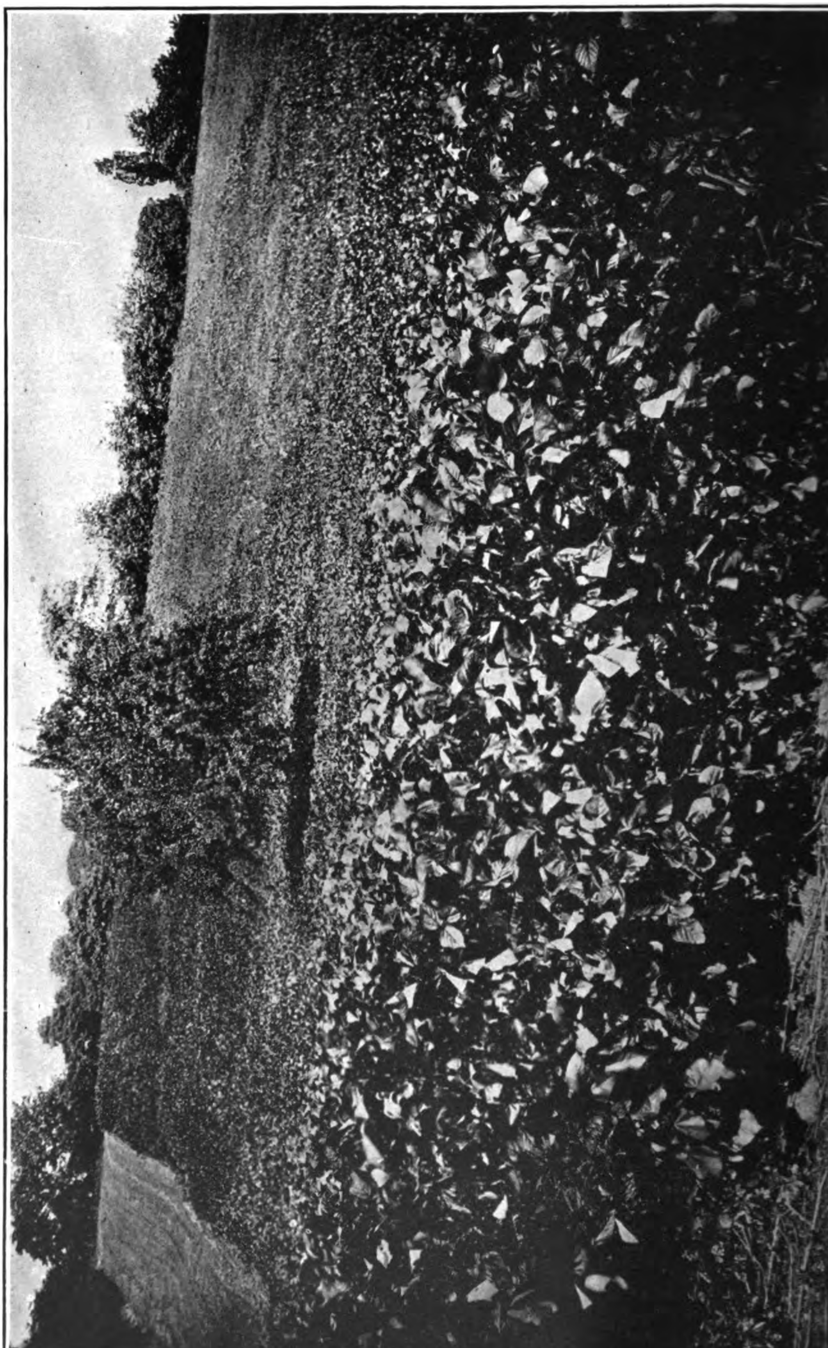
	OAT AND PEA FEED AND STRAW RATION.	OAT AND PEA I RATION.
	Per cent. fat.	Per cent. fat.
Cow No. 1	4.30	4.26
Cow No. 2	4.49	4.05
Cow No. 3	4.60	4.65
Cow No. 4	4.20	4.10
Average	4.40	4.27

Cows Nos. 1, 2 and 4 showed a slightly higher percentage of when fed the Oat and Pea Feed Ration, while cow No. 3 was .05 p cent. ahead on the Hay Ration. The average for the four cows slightly in favor of the Oat and Pea Feed Ration.

III. THE COST OF MILK AND BUTTER FROM THE TWO RATIONS.

The cost of producing milk and butter from the two rations h been calculated, using as a basis the actual cost of producing t foods, namely, $8.24 per ton for Oat and Pea Hay $6 per ton f Oat and Pea Straw, $22.60 per ton for Oat and Pea Feed and $2. per ton for silage. The cotton-seed meal was purchased for $ per ton.





sumed and the Yield and Cost of the Milk and Butter Product.

	Number of days.	FOOD CONSUMED PER COW PER DAY. Silage.	Oat and pea straw.	Oat and pea hay.	Oat and pea feed.	Cotton-seed meal.	Cost of ration.	YIELD OF— Milk.	Butter.	COST TO PRODUCE. 100 lbs milk.	1 lb. butter.
		lbs	lbs.	lbs	lbs.	lbs.	cts	lbs.	lbs.	cts.	cts.
Straw	30	30	5	......	7	3	19.36	1,691.9	87.24	61.6	11.9
a	30	30	.....	14	......	3	13.72	1,649.1	82.33	49.9	10.0

e table, the cost of food used to produce 100 pounds
ınd of butter was 61.6 cents and 11.9 cents respect-
and Pea Feed and Straw Ration, and 49.9 cents and
e Oat and Pea Hay Ration. A comparison of the
uct from the two rations is given in the following

	Milk produced, lbs.	Cost per hundred, cts.	Total cost.	Value at 3cts. qt.	Difference between cost and selling price.
d Straw	1,691.9	61.6	$10 42	$23 61	$13 19
tion	1,649.1	49.9	8 23	23 01	14 78

rved that while more milk was produced from the
ed and Straw Ration, this increase was more than
by the greater cost of production, hence the Oat and
eally proved the more profitable. The gain from the
l and Straw Ration and the Oat and Pea Hay Ration
ood is shown to be $13.19 and $14.78 respectively,
59 in favor of the Oat and Pea Hay Ration. Apply-
o a herd of thirty cows, the gain of the Oat and Pea
· the Oat and Pea Feed and Straw Ration would
per month. The results of these experiments indi-
l Pea Hay will not only take the place of feeds to
ıt will also produce milk more economically.

IV. THE INDIVIDUAL ANIMALS.

The weights of the cows were taken at the beginning and clo each test. The following tabulation shows the weights at the of the feeding tests, with the different rations :

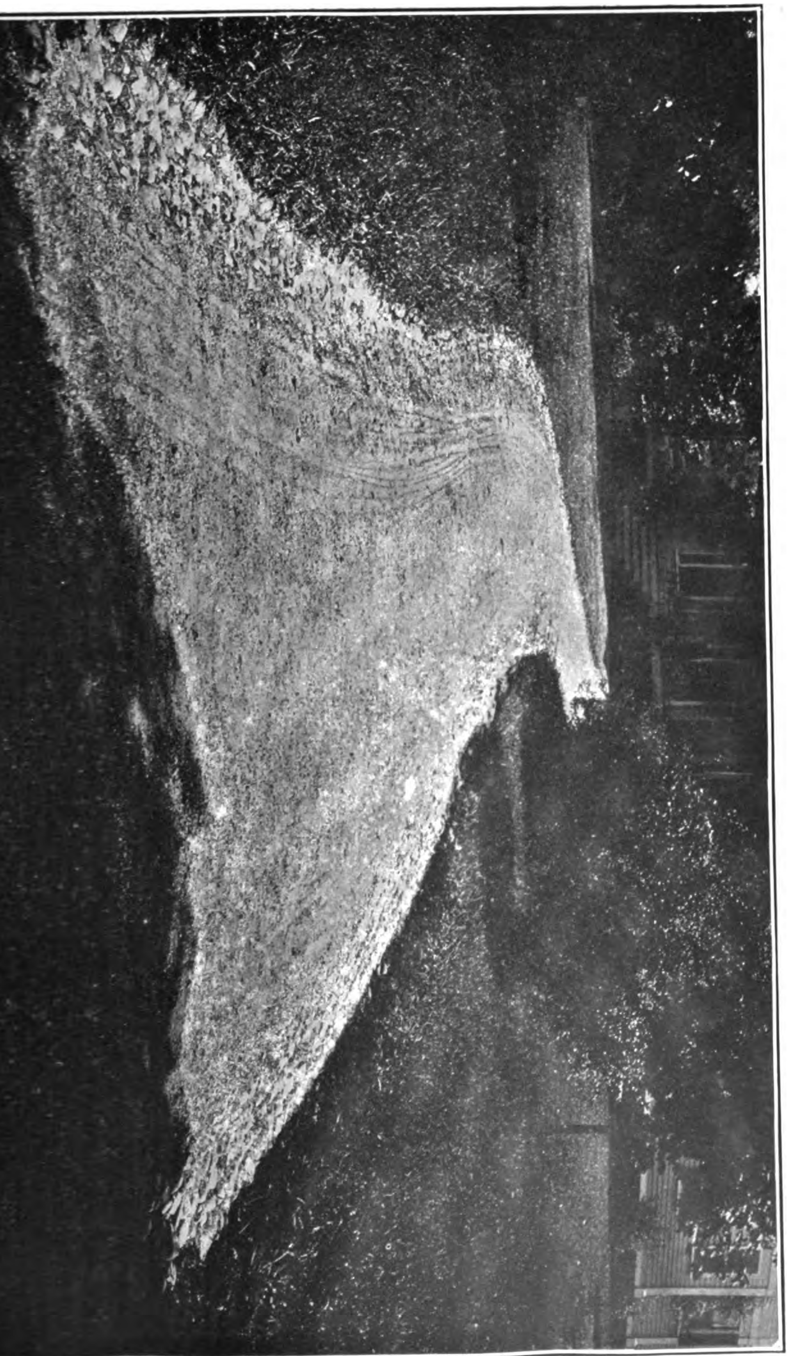
	OAT AND PEA FEED AND STRAW RATION.	OAT AND P HAY RATIO
Cow No. 1	960	985
Cow No. 2	1,015	1,000
Cow No. 3	1,070	1,080
Cow No. 4	970	975
Total	4,015	4,040
Average	1,004	1,010

The above shows that cows Nos. 1, 3 and 4 made the largest on the Oat and Pea Hay Ration, while cow No. 2 gained mor the Feed Ration. The average gain for the cows, taken as a w shows six pounds in favor of the Oat and Pea Hay Ration. experiments in growing oats and peas for grain and hay, see an report for 1900, page 264.

Farm Roads.

The results of some experiments in building roads about the Co Farm during the past three years may be of interest. A numb the factories in New Brunswick have a large supply of cinders to pose of daily, and these can usually be obtained without exp except cartage. This material was found valuable for road cons tion, and was used as a basis of three experiments.

I. Roads Made of Cinders.
II. Roads Made of Cinders and Gas Lime.
III. Roads Made of Cinders and Stone Lime.



I. ROADS MADE OF CINDERS.

ence in road making was with cinders alone. The
e about fifteen feet wide, with side ditches sufficient
. The road was elevated in the center and sloped
the ditches, the thickness of the cinders in the
seven to nine inches. It was always dry, and
ell for a short time, but needed frequent repairs,
that the cinders soon wore to a fine dust, allowing
ough; furthermore, where cinders were used alone
the water, hence washed out readily.

ADS MADE OF CINDERS AND GAS LIME.

onstructed in the same manner as the cinder road,
able fall, as shown in Fig. 10. Gas lime, costing
shel, was mixed with the cinders, in the proportion
bulk). A stream of water was allowed to run on
it was being mixed, to aid in packing. The mix-
uled to the road-bed and properly graded, care
ild the center high enough to shed water readily,
rolled with a heavy roller until compact. This
used three years, during which time it has been
ds of vehicles, heavy and light, and is in good con-
repairs have been made on it since it was built.
but one objection to this form of farm road, viz.,
me, which in damp weather is sometimes a little
obviate this objection we substituted stone lime

ADS MADE OF CINDERS AND STONE LIME.

structed of cinders and stone lime (slacked), in the
ne road described above. The stone lime, however,
expensive, costing twelve cents per bushel. This
se one year, and has stood the wear and tear equally
lime; in fact, there does not seem to be much dif-
ability of the two roads. Where the road is not
-house, the gas lime and cinders seem to answer all
of a road for general farm traffic; but if the road
dwelling-houses, the stone lime will be preferable.
oad constructed of stone lime and cinders.

Description of the New Wing of the Dairy Barn

A gradual increase in the dairy herd, and the need of better q ters for the bulls and young stock, made it necessary to buil addition to the dairy barn last spring. The building is a fr structure (Figs. 12 and 13), 38 feet long by 32 feet wide, proje at right angles from the main barn. It is one story high, the connecting with the second story of the main building, so that co foods can easily be transferred to the feeding floor of the new struc

Main Floor.—The plan of the main floor is shown in Fig. 15. ceiling is sheathed with matched lumber. The floor is mad Portland cement and coarse gravel (one part to eight), three in thick. This is covered with a layer of Portland cement one thick, making the total thickness of the floor four inches. manure gutters are sixteen inches wide and five inches deep slightly sloping surface in the stalls and gutters leads all wat the trap-doors, where it is conducted to cemented tanks below.

Mangers.—The mangers are built in and composed of the s material as the floor. A cross-section of the floor and mangers o stable is shown in Fig. 16. The depth of the manger is three in in the center, rounding up to the level of the floor. The wid one foot ten inches. It is used only as a feeding manger, the w being supplied in individual basins, which work automatically.

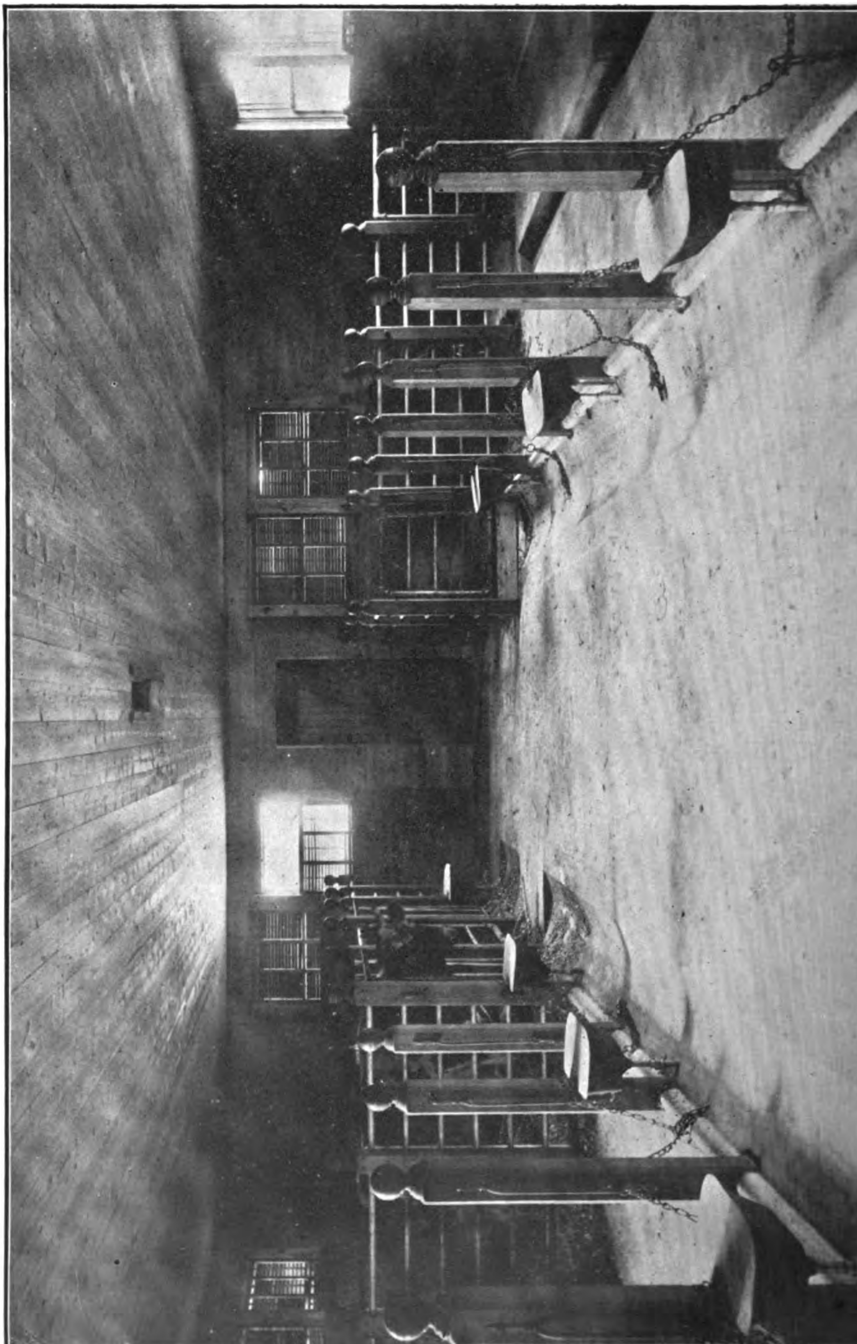
Stalls.—The stable contains thirteen stalls in two rows, which each other, besides two special stalls for bulls and two box st which may be used either for calves or for older animals. The f ing floor is seven feet wide. The two bull stalls, as well as the pens, are constructed of spruce posts, with frame-work of gas-p (Fig. 14.)

The cows are fastened simply with a bow chain, attached on e side to a spruce post five inches in diameter. (Fig. 14.)

The bull stalls are connected with outside pens, 12 x 26 feet, w the animals are turned out every day for exercise.

Basement.—Under the barn is a basement divided into two ro one of which is used for storing wagons and farm tools, while other contains the manure pits. These pits are frequently clea but the cement floor above prevents odors from reaching the m floor; hence the arrangement is a sanitary one.

Ventilation.—The system of ventilation originated by Prof. I was used in this barn, and is shown in Fig. 16. A single ventila flue (DE) rises above the roof of the barn, and is divided below



AD), which terminate near the level of the nese openings are provided with valves, which osed at will. Two other ventilators are placed hen the stable is too warm, but are provided d at other times. C is a direct ventilator, lead-t and opening from the ceiling, to admit a cur-ll times to the main shaft, to help force the ting shafts are made of matched boards care-ne flue is airtight. They are 6 x 16 inches and bove the roof, three feet square.

the stable on either side of the barn, as shown l the foul air is sent out at AA.

rcular in form, twelve feet inside diameter and a brick foundation ten inches wide, carried rface of the ground. The bottom is cemented he sills, which are made of 2 x 6 studding, cut lius of the silo circle, imbedded in mortar and The plates are made in the same way and h are 2 x 6 and 18 inches apart. The lining nesses of half inch boards (the inner layer of one of spruce), with tarred paper between, s tar and gasoline, mixed in the proportion of onsists of one layer of inch hemlock boards, een studs and covered with cedar shingles. each stud and covered with wire netting (Fig. on of air between the siding and lining, which f the latter. The structure is roofed as shown, for filling and with ventilating cap, and is a passage, also roofed. The silo is emptied by ter method" of continuous opening, the silage ute two feet square, upon the floor of the pas- it is conveyed to the mangers of the animals.

Cost of Producing Milk.

, 1896, records have been kept of the cost of nt and cost of foods eaten by the dairy herd, lk produced by each cow. The cost of produc-ears has been published in the annual reports. ending April 1st, 1901, is here reported. The ows.

TABLE IV.

The Kind, Amount and Cost of Foods for Thirty Cows fo Year, April 1st, 1900, to April 1st, 1901.

	Amount Fed. lbs.	Cost per ton.	Total.	
Wheat bran	34,000	$18 00	$288 00	
Dried brewers' grain	26,100	14 50	189 23	
Corn meal	15,000	21 00	157 50	
Linseed meal	1,800	28 00	25 20	
Cottonseed meal	9,000	27 00	121 50	
Pea meal	2,000	18 00	18 00	
Costs of feed				$799 4
Soiling Crops	360,000	$1 20	$216 00	
Silage	200,000	2 50	250 00	
Dried cornstalks	20,000	4 00	40 00	
Hay	30,000	5 34	80 10	
Roughage				$586 1
Total cost of food				1,385 5

Total cost of food	$1,385 53	
Cost per cow per day		12.65
Cost of feeds	799 43	
Cost per cow per day		7.30
Cost of roughage	586 10	
Cost per cow per day		5.35
Total yield of milk		89,851 quarts.
Average per cow per day		8.26 "
Cost of food per quart		1.54 cents.
Cost of feed per quart		.89 "
Cost of roughage per quart		.65 "

The cost of feeds represents what was actually paid. The c hay, cornstalks and soiling crops represents the actual cost of seed and manure, the farm manure being charged at the r $1.50 per ton.

The average cost of the daily ration was 12.65 cents, of whi cents or 57.7 is due to purchased feed and 5.35 cents or 42 cent. to the cost of farm crops. The total cost of producing including the cost of labor, and the interest on and decrease i value of the herd are given, the latter item being estimated.

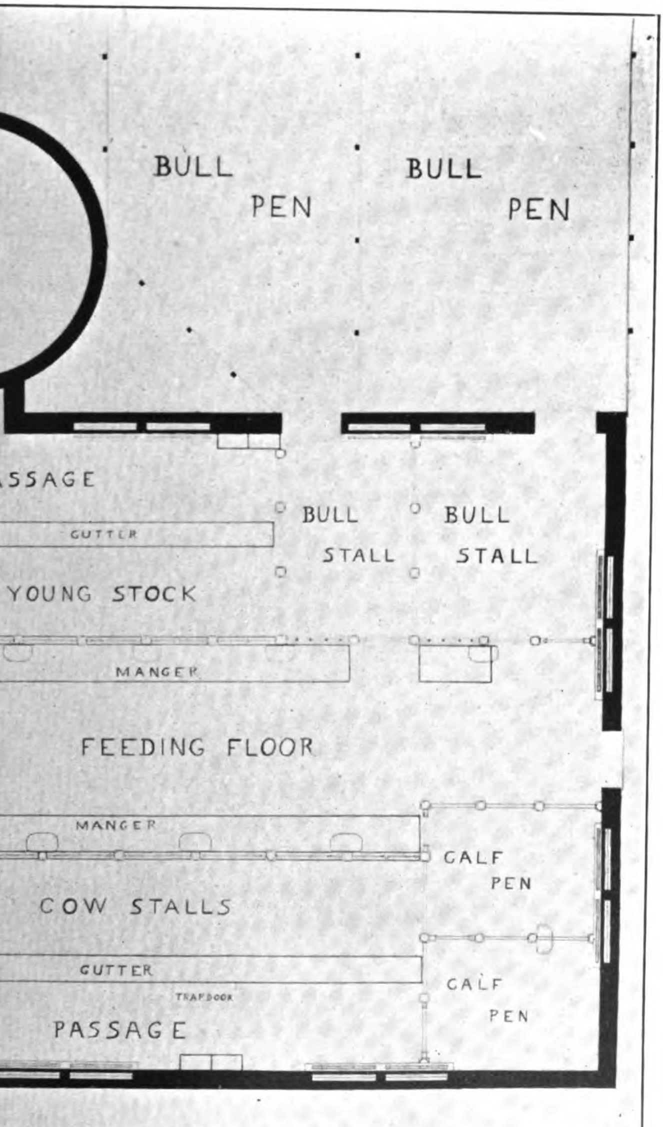
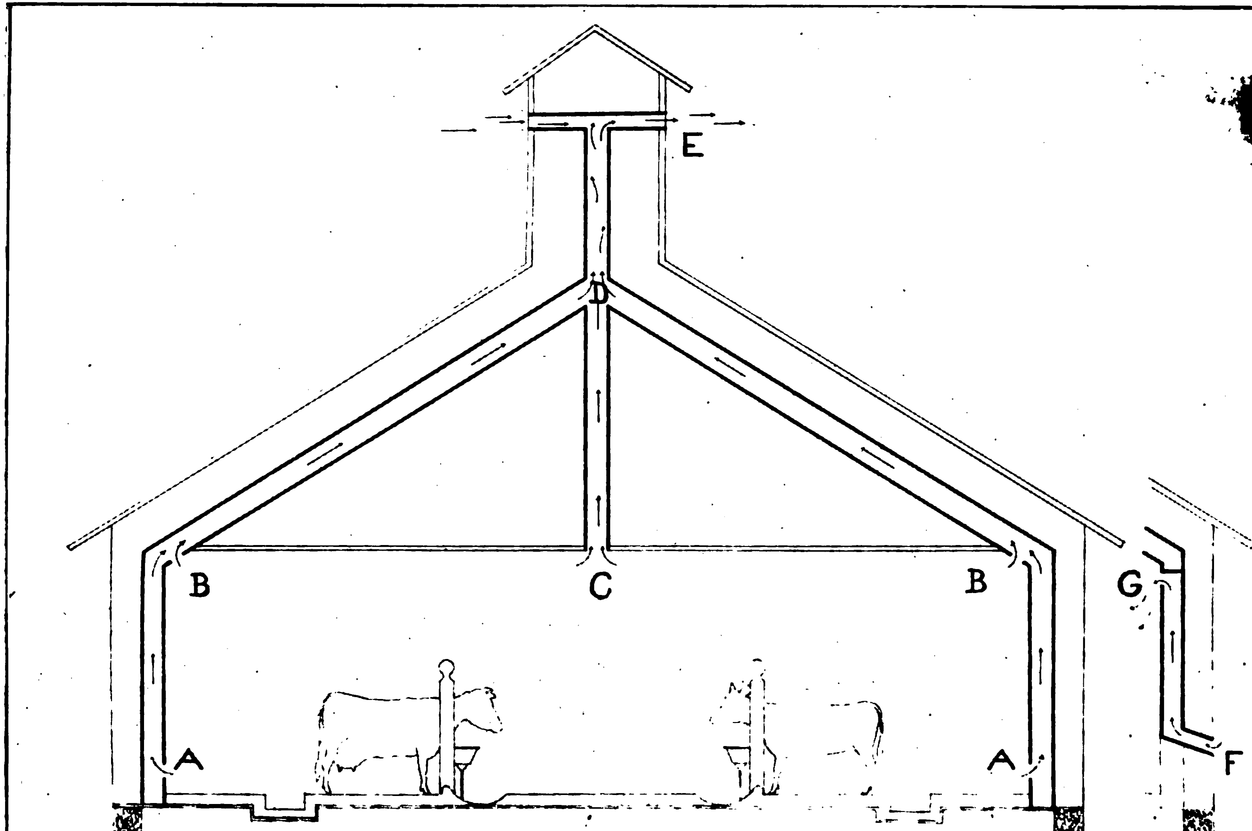


Fig. 15.
howing Floor Plan of New Wing of Main Barn.


E
D
B
C
B
G
A
A
F

TOTAL COST OF PRODUCING MILK.

tement		$1,385 53
	$600 00	
ie herd, at 5 per cent	60 00	
ue herd, at 5 per cent	60 00	
		720 00
		$2,105 53
r quart of milk		1.54 cents.
d interest per quart of milk		.80 "
t per quart		2.34 cents.

ights per quart of milk, as put up in bottles for 3 pounds, hence the total weight of milk, 195,875 alent to 89,851 quarts. The cost per hundred was, At $1 per hundred, the price received in rural its from the business, if any, must be in the calculation of the cost of farm foods, the manure rate of $1.50 per ton. The amount produced by he year was 330 tons. In selling milk at $1 per ipts are $146.78 less than the expenses. Deduct-rom the actual charges made for the manure, in ie crop—$1.50 per ton—there remains $348.22, the profits from thirty cows—an amount too small ess pay.

er quart, the price that could have been received at ipts would have amounted to $2,695.53. Deduct-rchased feeds, labor and interest, and decrease in erd, amounting to $1,519.43, we have a balance of represents the value of the home-grown produce; , at three cents per quart, the farm would sell its uce at profitable prices, namely, $2.45 for soiling ge, $10.47 for hay and $8 per ton for dried corn the crops over cost of production of $1.25 per ton 2.50 for silage, $5.13 for hay and $4 for dried corn additional gain represented by 330 tons of manure. iestion of profit from another standpoint, we will lairyman performs the work himself. Deducting, of labor, which amounted to $600, from the total ($2,105.53), we have a balance of $1,505.53. int by the total pounds of milk produced (195,875),

we find the cost per hundred 76.9 cents. The difference, ther
between the cost and selling price of the milk represents the
man's profits from the business when he performs the work hi

Assuming that the milk produced by the above thirty cow
been sold for $1 per hundred, a profit of 23.1 cents would hav
realized in every hundred pounds, or a total of $452.47 for the
production, besides the additional gain represented by 330 t
manure. At three cents per quart, the profits would have amo
to $1,190, besides the additional gain represented by the manu

TABLE V.

Average Cost of Producing Milk for Five Years.

YEAR.	Number of cows.	MILK PRODUCED. Pounds.	Quarts.	Average yield per cow.	COST PER COW PER DAY. Feeds.	Roughage.	Total.	COST PER QUA[RT OF] MILK OF— Feeds.	Roughage.	Labor and Interest.
				lbs.	cts.	cts.	cts	cts.	cts.	cts
1896	23	141,517	64,916	6,153	4.99	6.61	11.60	.646	.8[illegible]5	.9
1897	25	154,768	70,990	6,191	5.06	6.38	11.44	.650	.820	.9
1898	25	172,726	79,232	6,911	6.53	6.16	12.69	.750	.710	.8
1899	30	193,345	90,984	6,612	6.65	6.58	13.23	.800	.790	.7
1900	30	195,875	89,851	6,529	7.30	5.35	12.65	.890	.650	.8
Average		172,646	79,195	6,479	6.11	6.21	12.32	.747	.765	.8

The average production per year for the five years is shown
172,646 pounds, equivalent to 79,195 quarts. The average yiel
cow was 6,479 pounds. The average cost of food per cow pe
was 12.32 cents, of which 6.11, or 49.6 per cent., is due to purc
feeds, and 6.21, or 50.4 per cent., to the cost of farm crops.
average cost per quart of milk for the five years, including food,
and interest and decrease in the value of the herd, is shown
2.38 cents.

SOILING CROP ROTATION.

of crops, shown in Table VI., furnished a con-
forage for the dairy herd from May 1st until
the exception of two weeks in October, when
fed. The red clover on acre 1, the rye on acres
peas and sorghum on acre 3, the cow peas on
fa on acre 10, were used for green manure. The
e for all crops in the year's rotation shows a
Leaving out of consideration the crops that were
one acre yielded less than ten tons, three acres
e tons, and less than fifteen, six yielded over
s than twenty, while three yielded over twenty

the amount of nutrients obtained per acre from
tions of crops, with that contained in clover hay,
ea of their feeding value. For example, on acre
equivalent to that contained in 6.7 tons of clover
of wheat bran. On acres Nos. 5 and 6 it is
in 4.2 tons of clover hay; in Nos. 1, 2, 11 and
Tos. 3, 4, 7, 8 and 12, to 2.3 tons, and in No. 10,

ase, the proportion of carbohydrates exceeds the
l in clover hay, thus making the nutrients com-
crop. The nutrients contained in three tons of
rn meal respectively, are also added in the table

ree crops are grown upon an acre in a year, but
of plots 5 and 6, the yield from but two crops is
ner crop was turned under. The actual yields,
f the thirteen acres, was larger than is indicated.

TABLE VI.

Soiling Crops—Number, Kind and Acreage, 1901.

Number of acre.	CROP ROTATION.	Yield per acre.	NUTRIENTS. Protein.	Ether ex-tract.
		tons.	lbs.	lbs.
1	*Red Clover	....	....	....
	Oats and Peas	6.2	657.2	81.8
	Cow Peas and Kaffir Corn	12.2	334.3	134.2
	Total	18.4	991.5	216.0
2	*Rye	....	....	....
	Oats and Peas	6.2	657.2	81.8
	Cow Peas and Kaffir Corn	12.2	334.3	134.2
	Total	18 4	991.5	216.0
3	Wheat	5.2	288.6	93.6
	Barnyard Millet	11.6	373.5	204.2
	*Cow Peas and Sorghum	....	....	....
	Total	16.8	662.1	297.8
4	Wheat	5.2	288.6	93.6
	Barnyard Millet	11.6	373.5	204.2
	*Cow Peas	....	....	....
	Total	16.8	662.1	297.8
5	Rye	9.6	498.2	115.2
	Soy Beans	8.8	501.6	96.8
	Barley	2.6	140.4	31.2
	Total	21.0	1,140.2	243.2
6	Rye	9.6	498.2	115.2
	Cow Peas	10.5	604.8	161.7
	Barley	2.6	140.4	31.2
	Total	22.7	1,243.4	308.1
7	*Rye	....	....	....
	Oats and Peas	4.1	434.6	54.1
	Pearl Millet	9.2	207.9	68.1
	Total	13.3	642.5	122.2
8	*Rye	....	....	....
	Oats and Peas	4.1	434.6	54.1
	Pearl Millet	11.0	248.6	68.1
	Total	15.1	683.2	122.2
9	Alfalfa	21.7	1,303.3	334.1
	Total	21.7	1,303.3	334.1
10	*Alfalfa	....	....	....
	White Flint Corn	9.1	300.8	112.8
	Total	9.1	300.8	112.8
11	Oats and Peas	8.3	349.8	43.6
	Cow Peas	3.0	460.8	123.2
	Total	11.3	810.6	166.8

* Used for green manure.

TABLE VI—Continued.

ps—Number, Kind and Acreage, 1901.

TATION.	Yield per acre.	NUTRIENTS. Protein.	Ether extract.	Fiber and N. free extract.
	tons.	lbs.	lbs.	lbs.
....	4.7	243.9	56.4	1,720.0
....	14.0	380.8	142.8	3,290 0
....	18.7	624.7	199.2	5,010.0
....	10.2	958.8	244.8	4,284.0
....	10.2	958.8	244.8	4,284.0
ntains........		1,080	264	5,040
"		810	198	3,780
"		540	132	2,520
contains........		924	246	3,240
"		558	228	4,200

Business in Relation to Soil Exhaustion.

le shows the amount of fertilizing elements con-
purchased, and in the milk produced, by a herd
25 cows in the years 1897 and 1898, and 30 cows

TABLE VII.

KINDS.	AMOUNT.					NITROGEN.					PHOSPHORIC ACID.					POTASH.				
	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.
	tons.	tons.	tons.	tons.	tons.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Wheat Bran	9.40	12.50	14.50	15.85	17.00	460	612	710	777	833	545	725	841	919	986	301	402	464	507	544
Dried Brewers' Grains	9.20	8.15	10.25	13.75	13.05	662	587	838	990	940	202	179	226	303	287	15	13	17	22	21
Corn Meal	6.10	3.30	5.00	7.05	7.50	201	109	165	233	248	85	46	70	99	105	49	26	40	56	60
Linseed Meal	3.55	4.45	3.50	1.05	.90	377	473	372	111	95	126	158	124	38	32	97	121	96	29	24
Cottonseed Meal	......	......	......	1.75	4.50	......	......	......	238	612	......	......	......	106	275	......	......	......	66	171
Rice Meal	......	......	1.75	2.70	......	......	......	69	105	......	......	......	94	145	......	......	......	25	39	......
Pea Meal	......	......	......	......	1.00	......	......	......	......	32	......	......	......	......	16	......	......	......	......	20
Buckwheat Feed	......	......	.50	1.60	......	......	......	36	29	......	......	......	18	58	......	......	......	13	42	......
Total or gain in feeds	......	......	......	......	......	1,700	1,781	2,190	2,483	2,760	958	1,108	1,373	1,668	1,701	462	562	655	761	840
Sold in Milk	70.86	77.38	86.36	99.17	97.94	849	927	1,036	1,190	1,173	318	347	389	446	440	248	271	302	347	343
Gain to farm	......	......	......	......	......	851	854	1,154	1,293	1,587	640	761	984	1,222	1,261	214	291	358	424	497

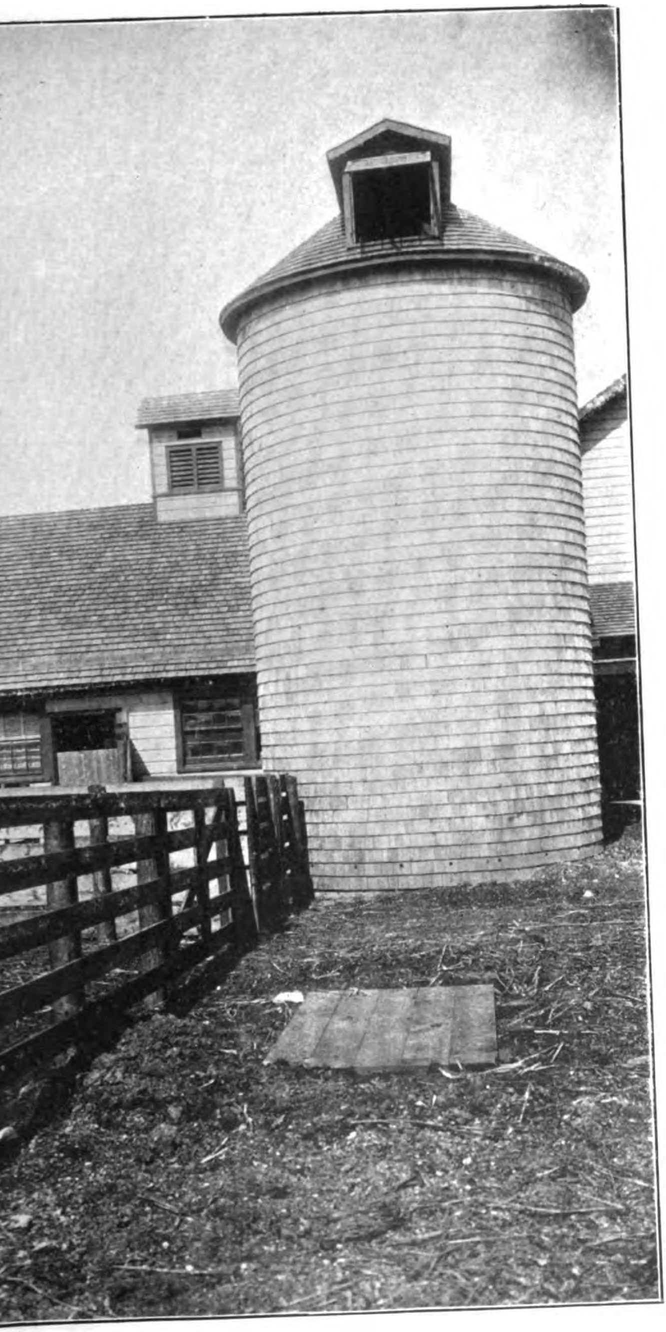
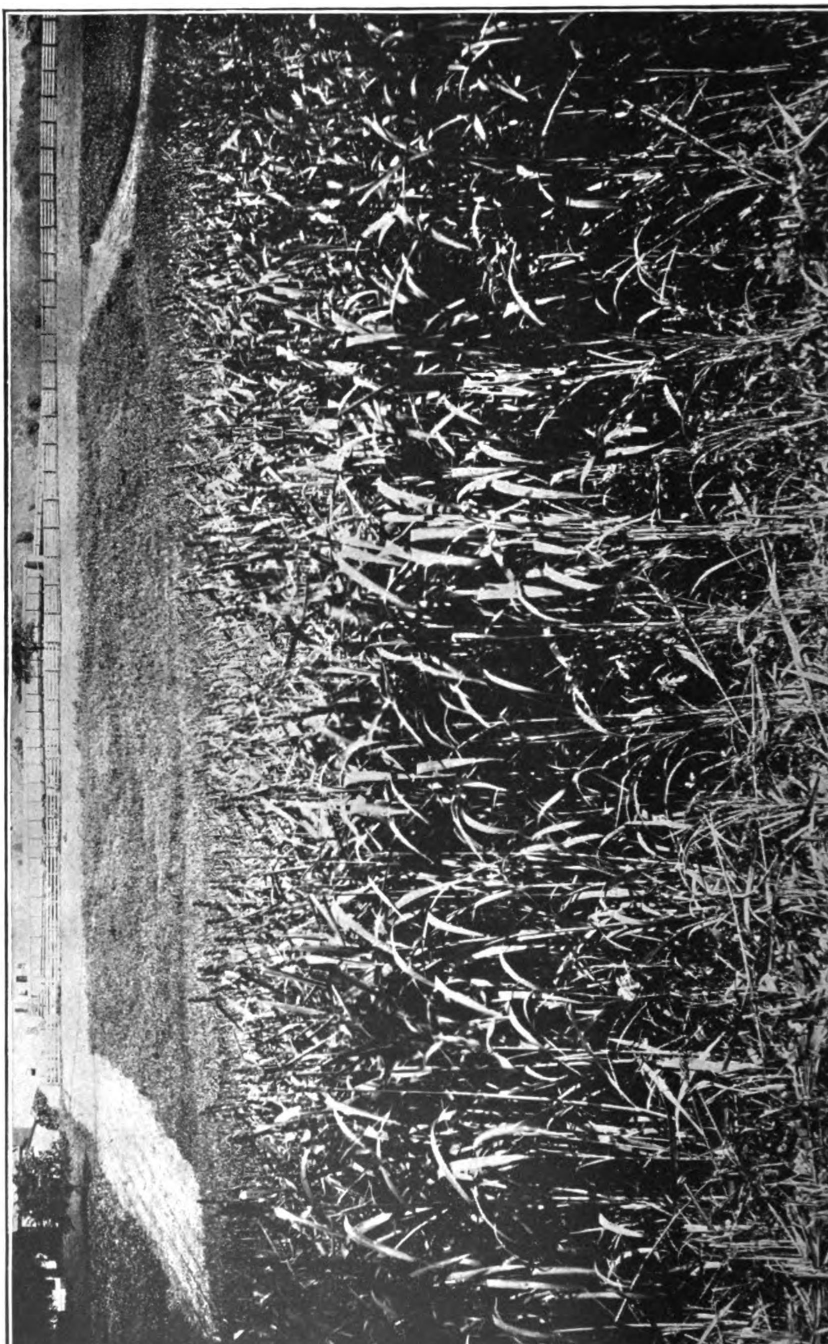


Fig. 18.

iew of Wing to Dairy Barn, showing Silo and outside Bull Pen.



ble shows a decided gain to the Farm in fertility
; all five years. The total gain is equivalent in
hosphoric acid to that contained, respectively, in
rate of soda and 20.4 tons of acid phosphate, and in
ontained in 1.78 tons of high-grade muriate of potash.
d that the constituents contained in the manure are
tural value to those contained in the fertilizers men-
even under the best conditions of care and applica-
all be used by the plants, but, because the manure
constituents and is well adapted for most crops, the
s, as a rule, able to get as good returns from it in
nstituents contained as from products containing the
ts in more available forms.
n shows that if all the milk sold from the Farm was
oods grown on the Farm, the exhaustion of nitrogen
eater proportion than the mineral elements, and that
ractice, it is necessary to apply nitrogenous fertilizers
ntain the fertility. If manure is well cared for and
t is more economical to purchase the nitrogen in the
stuff, whose whole cost is returned in the increased
g from the use of the well-balanced rations.

DAIRY HERD, APRIL 1ST, 1900, TO APRIL 1ST, 1901.

ril 1st, 1896, complete records have been kept of the
uding the yield and composition of the milk of indi-
The records have been published annually in the

ists largely of grade animals ; three Guernseys, four
one Holstein are pure bred. Twenty-six animals
herd throughout the entire year, and their records
e tabulation. Many of the cows giving the lower
een valuable animals in past years, but have now
ofitable, and will be disposed of during the present
age, however, for the herd is 6,545 pounds.
own, under "Cost of Producing Milk," the foods
only such as to provide a sufficient and well-bal-
Soiling crops were fed for six months and silage the
e year. In connection with the weight of the milk
n from each animal daily, the product from each
d and analyzed once each week. The accompanying
monthly yield of milk and its composition, as well
d per cow of milk, of fat and of butter.
uivalent is derived from the fat by adding one-sixth.

TABLE VIII.

Record of the Dairy Herd.

Number of cow.		April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per cent. of fat.	Total fat.	Equivalent to butter.
1	Pounds of Milk.....	523.1	539.2	553.6	460.3	398.8	280.2	459.9	544.0	531.2	582.0	583.7	605.5	6,066.0	4.0	240.98	281.09
	Per Cent. of Fat.....	3.9	4.0	3.7	3.8	4.3	4.4	4.1	4.1	3.9	4.0	3.9	3.9	....			
2	Pounds of Milk.....	1,361.4	1,275.9	1,181.2	917.4	869.9	824.2	758.0	504.8	378.3	220.1	....	123.5	8,351.7	4.2	348.90	407.05
	Per Cent. of Fat.....	4.1	4.2	3.9	4.0	4.2	4.2	4.4	4.5	4.2	4.6	....	4.3	....			
3	Pounds of Milk.....	571.1	315.6	34.8	35.5	1,160.4	1,099.7	1,084.7	836.1	830.8	892 2	795.0	860.9	8,516.8	4.1	349.20	407.40
	Per Cent. of Fat.....	4.9	5.1	5.1	5.1	3.8	3.5	3.8	3.9	4.2	4.2	4.2	40.5	....			
4	Pounds of Milk.....	1,171.4	1,067.6	939.8	821.4	768.4	781.3	610.1	583.9	390.0	35.4	....	....	7,063.8	4.3	302.01	352.35
	Per Cent of Fat.....	4.1	4.3	3.9	4.1	4.4	4.2	4.6	4.7	4.8	4.8	....	....	....			
5	Pounds of Milk.....	828.6	948.8	865.1	464.8	....	....	....	214.2	1,005.9	1,066.4	977.0	994.2	7,360.0	4.1	305.08	355.93
	Per Cent. of Fat.....	4.0	4.1	3.8	4.4	....	....	....	4.7	4.7	4.1	4.0	4.0	....			

Number of		April.	May.	June.	July.	August.	September	October.	November	December.	January.	February.	March.	Total yield	Average p	Total fat.	Equivalent
8	Pounds of Milk.....	339.4	944.3	885.6	729.2	594.4	328.1	86.8	....	332.2	1,591.5	1,301.4	1,378.7	9,006.6	3.5	319.29	372.51
	Per Cent. of Fat.....	3.5	3.4	3.3	3.6	4.1	3.7	4.1	....	3.5	3.5	3.6	3.5	....			
9	Pounds of Milk.....	593.7	579.5	479.0	602.4	666.8	639.3	540.7	553.3	583.9	505.5	510.9	563.1	6,818.1	4.3	294.75	343.88
	Per Cent. of Fat.....	4.5	4.5	3.9	4.2	3.8	4.0	4.5	4.2	4.5	4.8	4.4	4.7	....			
10	Pounds of Milk. ...	536.6	458.5	422.5	644.0	656.6	592.1	600.9	601.5	537.2	438.0	366.3	413.0	6,267.2	4.6	288.62	336.72
	Per Cent. of Fat.....	4.8	5.3	4.8	4.2	4.1	4.4	4.7	4.4	4.6	4.8	4.8	4.9	....			
11	Pounds of Milk.....	803.0	838.5	788.6	688.4	677.9	604.9	308.8	....	....	....	....	479.4	5,189.5	4.4	229.12	267.31
	Per Cent. of Fat.....	4.7	4.7	4.2	5.1	3.9	4.4	5.8	....	....	....	....	4.1	....			
12	Pounds of Milk.....	420.4	462.7	399.5	325.4	547.8	549.5	539.4	568.6	608.7	543.6	442.0	444.7	5,852.3	4.7	272.14	317.50
	Per Cent. of Fat.....	4.9	4.7	4.8	4.7	4.4	4.1	4.2	5.1	4.9	4.7	4.7	4.7	....			
13	Pounds of Milk.....	487.3	580.2	553.4	480.0	412.9	295.5	47.9	....	874.6	1,084.4	991.1	1,033.9	6,841.2	4.5	309.59	361.19
	Per Cent. of Fat.....	4.5	4.8	4.7	4.5	4.9	5.2	6.1	....	4.8	4.5	4.4	3.8	....			
14	Pounds of Milk.....	646.2	764.7	702.4	589.9	565.4	537.5	459.5	229.5	....	....	....	....	4,495.1	4.8	215.61	251.55
	Per Cent. of Fat.....	4.5	4.8	4.3	4.7	4.7	5.1	5.3	5.9	....	....	....	....	....			

TABLE VIII.

Record of the Dairy Herd—Continued.

Number of cow.		April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per cent. fat.	Total fat.	Equivalent to butter.
15	Pounds of Milk.....	372.0	456.8	418.9	212.2	379.8	465.6	434.8	418.8	408.8	375.0	364.6	304.1	4,549.9	4.5	205.99	240.32
	Per Cent. of Fat....	4.5	4.3	4.6	4.9	4.4	4.1	4.0	4.6	4.3	4.6	5.0	5.0	....			
16	Pounds of Milk.....	....	....	....	414.7	895.7	899.6	860.8	785.6	802.5	728.7	650.6	636.8	6,660.5	4.5	298.72	348.51
	Per Cent. of Fat....	....	....	....	3.6	4.2	4.1	4.4	4.3	4.7	4.6	4.9	4.9	....			
17	Pounds of Milk.....	470.3	511.1	446.5	406.9	405.6	840.4	219.8	77.8	....	561.1	840.7	855.8	5,164.5	5.3	275.70	321.65
	Per Cent. of Fat....	5.6	5.6	5.5	5.5	4.3	6.0	6.1	6.9	....	5.0	5.2	5.1	....			
18	Pounds of Milk.....	1,324.8	1,314.9	1,115.5	886.2	792.0	770.9	687.6	391.4	55.6	....	....	1,152.7	8,444.1	3.9	331.20	386.40
	Per Cent of Fat.....	3.6	3.9	3.8	3.9	4.1	4.1	4.3	4.7	4.7	....	....	3.7	....			
19	Pounds of Milk.....	387.5	412.5	352.2	292.8	335.5	321.7	252.6	70.5	....	254.1	783.9	597.6	4,010.9	4.5	179.15	209.01
	Per Cent. of Fat....	4.4	4.6	4.3	4.2	4.3	4.5	5.0	6.3	....	4.0	4.5	4.5	....			
20	Pounds of Milk	....	....	....	....	81.8	495.3	741.1	594.6	641.8	599.0	508.7	521.1	4,128.4	[illegible]	[illegible]	[illegible]

Number of cow		April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per ce	Total fat.	Equivalent to b
22	Pounds of Milk.....	....	....	659.8	309.6	755.6	573.2	512.8	474.1	442.6	359.9	246.7	331.2	5,165.0	5.2	267.11	311.68
	Per Cent. of Fat.....	....	....	4.7	4.8	5.0	5.0	5.1	5.7	5.1	5.9	5.8	5.9	....			
23	Pounds of Milk	720.8	696.9	536.5	48.5	....	....	....	871.0	1,221.8	1,026.8	357.0	399.0	6,378.3	3.9	266.99	311.49
	Per Cent. of Fat.....	3.8	4.0	4.0	4.0	....	....	....	3.9	3.6	4.0	4.1	3.8	....			
24	Pounds of Milk	316.1	88.5	....	....	....	726.4	877.5	695.9	667.7	601.7	506.8	503.2	4,983.8	4.5	228.48	260.67
	Per Cent. of Fat.....	4.9	5.5	....	....	....	4.8	4.4	4.5	4.4	4.4	4.3	4.1	....			
25	Pounds of Milk.....	472.0	535.8	482.6	181.9	....	....	198.4	1,052.3	998.5	884.3	885.4	911.0	6,496.7	4.5	292.85	341.66
	Per Cent. of Fat.....	4.9	4.7	4.7	5.3	....	....	4.3	4.5	4.5	4.4	4.8	4.8	....			
26	Pounds of Milk.....	1,153.2	1,160.4	1,078.5	911.9	889.0	861.6	802.0	628.6	656.5	721.2	629.1	632.2	10,119.2	3.8	387.88	452.47
	Per Cent. of Fat.....	3.6	3.6	3.4	3.6	3.5	3.6	4.0	4.5	4.3	4.2	4.1	4.5	....			
	Average.	....	....	....	....	....	....	....	....	....	....	....	....	6,545.0	4.29	280.87	327.68

In a herd of grade cows representing several breeds, it is n
that there should be a wide variation both in the yield and co
tion of the milk produced by the individual animals. Whil
are two distinct classes of dairy cows, viz., milk produce
butter producers, there are also many animals of mixed br
which combine these two characteristics in a remarkable d
This point is clearly brought out in the following tabul
1. Yields of milk. 2. Yields of butter. 3. Yields of milk an
ter from animals which combine in a marked degree the quali
both milk and butter production.

1. Yields of Milk.

5 cows.........	an average of more than	4,000 lbs. and less than	5,000 lb
5 "	" "	5,000 " "	6,000 "
7 "	" "	6,000 " "	7,000 "
2 "	" "	7,000 " "	8,000 "
5 "	" "	8,000 " "	9,000 "
1 cow	" "	9,000 " "	10,000 "
1 "	" "	10,000 "	

The best cow produced..10,119.2 l
The poorest cow produced 4,010.9

Difference between the highest and the lowest.............. 6,108 3 l
The average per cow was.. 6,545.0

2. Yields of Butter.

1 cow.............	an average of more than	150 lbs. and less than	200 lb
2 cows............	" "	200 " "	250 "
4 "	" "	250 " "	300 "
9 "	" "	300 " "	350 "
7 "	" "	350 " "	400 "
2 "	" "	400 " "	450 "
1 cow.............	" "	450 "	

The best cow produced.. 452 lbs.
The poorest cow produced.. 187 "

Difference between the highest and lowest.................. 265 lbs.
The average per cow was.. 327 "

Fig. 6.

A Crop of Cow Peas and Southern White Corn.

3. **Yield of Milk and Butter.**

which combine in a marked degree the qualities of utter production.

	Breed	Yield of Milk. Lbs.	Yield of Butter. Lbs.
2	Grade Jersey	8,351	407
3	" Holstein	8,516	407
4	" Shorthorn	7,063	352
5	" Jersey	7,360	355
6	" Holstein	8,014	388
7	" "	8,300	375
8	" "	9,006	372
18	" "	8,444	386
26	Pure Bred Holstein	10,119	452

percentage of butter fat was from 3.5 per cent. to 5.2 n average of 4.29 per cent. It has been shown that ns per cow per day was 12.65 cts. or a total of $46.17 wing the same line of comparison, the advantages of are strongly shown in the following tabulation :

	At 1 cent per lb.	At 3 cents per qt.	Cost of food.	Gain over Food. At 1 cent per lb.	Gain over Food. At 3 cents per qt.
roduct of g more milk	$75 75	$104 25	$46 17	$29 58	$58 08
roduct of ling less milk	48 97	67 38	46 17	2 80	21 21
of the	65 45	90 06	46 17	19 28	43 89

er pound, the yield of the 16 cows producing more nds of milk is sufficient to pay for their food and manure, for care and profit, while the average yield roducing less than 6,000 pounds of milk is sufficient feed and only $2.80, besides manure, for care and nce of $26.78 in favor of the better cows. At 3 cents turns of the cows yielding over 6,000 pounds of milk, , are increased to $58.08, while for the cows yielding pounds of milk, they are increased to $21.21, or less those of the better cows at one cent per pound.

The facts brought out by this study indicate that but little is derived from a cow that does not produce 5,000 pounds of per year, particularly if the milk is sold at the low price of on per pound. No stronger argument is needed in favor of the nec of testing the animals and thus learning their exact value, t afforded by the above records.

When butter is made, practically all the fertilizing consti in the whole milk remain upon the farm, and these, togethe the feeding value of the skim milk, which is estimated by c feeders to be twenty cents per hundred, is an offset against the labor in making butter.

	20 cts. lb.	Foods.	Gain Foo
Average value of the product of the 19 cows yielding over 300 lbs. of butter..............	$71 80	$46 17	$25
Average value of the product of the 7 cows yielding less than 300 lbs. of butter........	48 40	46 17	2
Value of the product of average cow.........	65 60	46 17	19

The tabulation shows that the nineteen cows yielding ove pounds of butter paid for their food and $25.63, in addition to milk and manure, to represent the care and profits, while the m and skim of the seven cows yielding less than 300 pounds of b in addition to $2.23, represent the pay received for their care ar labor of making the butter. The facts brought out by the records indicate that there is but little profit from a cow that do produce 200 pounds per year, and point to the necessity of a ca selection of animals for the butter dairy.

It was desired at the outset to build up a herd that would pr milk containing at least 4 per cent. of fat. The average per of fat in the herd milk has exceeded this amount each year, as s by the following:

1897..	4.25	per cent. fat.
1898..	4.44	" "
1899..	4.50	" "
1900..	4.57	" "
1901..	4.33	" "

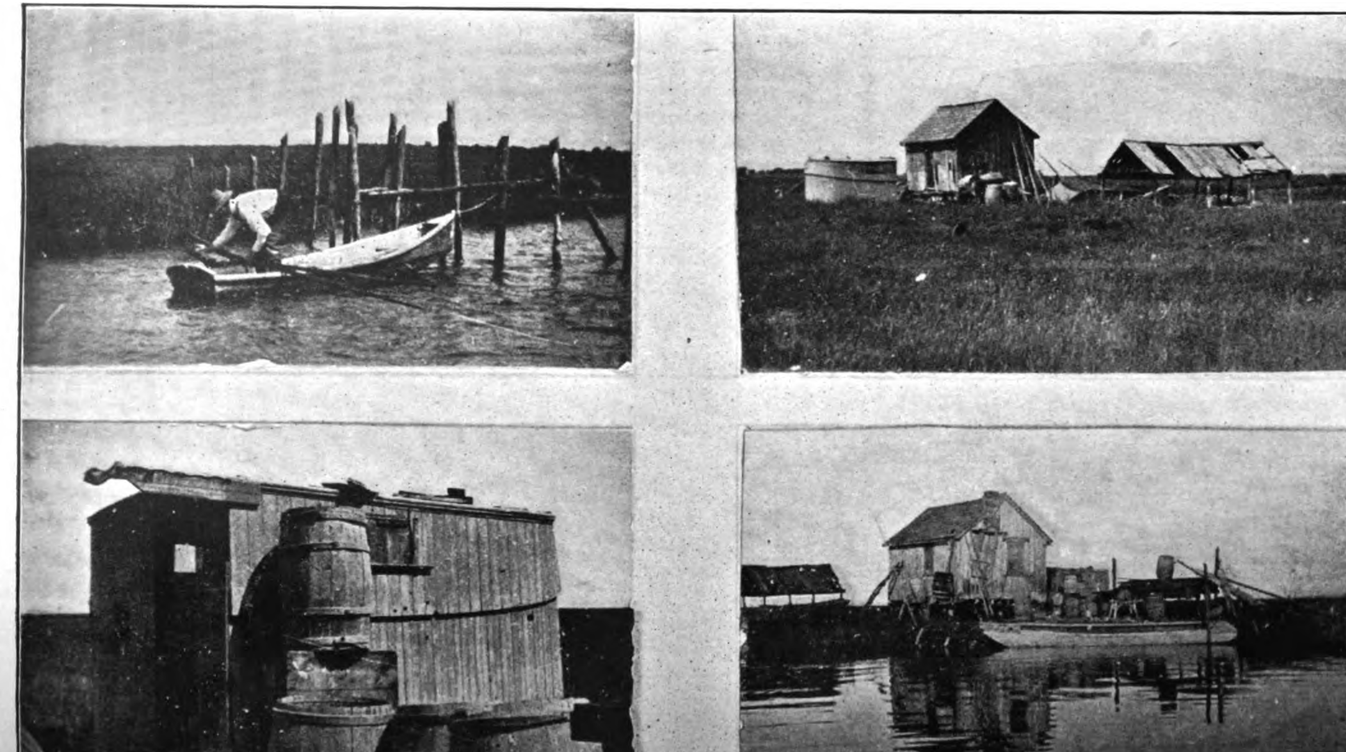
Wastes in Handling and Delivery.

ord has been kept of the amount of milk wasted in g, bottling and delivery. The waste during the past wn in the following tabulation :

	Waste in Handling, Cooling and Bottling. per cent.	Waste in Delivery or Dippage, per cent.	Total Waste, per cent.
....	5.7	5.1	10.8
....	4.4	4.9	9.3
....	4 8	2.0	6.8
....	4.7	1.7	6.4
....	3.8	1.7	5.5

ears 1897 and 1898 about 50 per cent. of the milk at the actual loss due to dippage was practically 10 e years 1899, 1900 and 1901 the proportion of milk tles was gradually increased, and the waste from this ced to 2.0 and 1.7 per cent., respectively. While the ncreases the expense of delivery, due to extra weight wagon, the extra work in cleaning, and the breakage es, which amounted to 10 cents per day per hundred ease in waste has more than offset the extra cost.

REPORT OF BIOLOGIST.



.NATION OF FRONTISPIECE.

)YSTER EXPERIMENT STATION, NEAR TUCKERTON, N. J.

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ur photographic views of the Mott Oyster Station and its environments
y, from left to right (upper views first):
g oysters for experimental purposes from the creek.
dings from the east, showing from left to right the laboratory, the "hotel
eding shed.
ry from west, nearer view.
s from west, looking across the creek.

REPORT OF BIOLOGIST.

'IC STUDIES OF OYSTER PROPAGATION.

[THE FERTILIZATION OF THE EGG.]

ec. 1. The Oyster Experiment Station.

ıre of the State of New Jersey, during the session of s appropriating more than $25,000 for the protection ıdustry and for increasing natural oyster seed. Of nce was the passage of an act providing for the leasyster planting grounds in Delaware bay at twenty-

ation which, from the standpoint of science and the r culture, was the most significant that was enacted re was the passage of an act providing for the estab- or more stations for the "scientific investigation of on," to-wit (Chapter 99, Laws of New Jersey, 1901) : ed by the Senate and General Assembly of the State

ctor of the New Jersey Agricultural College Experi- New Brunswick is hereby authorized to establish ne or more stations for the scientific investigation of ion, said station or stations to be situate at some in the oyster growing sections of this state. The zed to be expended under the provisions of this act l the sum of two hundred dollars in any one year ; o moneys shall be drawn from the treasury for the act until the same shall have been specifically approg to law.

shall take effect immediately.

Iarch 21, 1901."

hapter 210, paragraph 88) making appropriation for proved March 22d, 1901, did not go into effect until

November 1st, 1901, *i. e.*, after the oyster breeding season for year was ended. Nevertheless, it was thought best not to los first season, which gave opportunities for carrying into effec provisions of a law already in force; and so at the opening o spawning season, in June, the Biologist of the Station advised Geo. A. Mott, of Tuckerton, N. J., as to the appliances require Oyster Experiment Station No. 1, or as it shall hereafter be ca the "Mott Oyster Experiment Station."

This, the first Station established under the law, was thus na by the Biologist, because of its situation upon Mr. Mott's prop because of Mr. Mott's share in its erection and in the work ca on there, and because of his share in securing the passage of th creating such stations.

The situation, so far as conditions necessary to oyster growth concerned, is unexcelled, if not unequaled, by any other site w the State known to the Biologist. But successful experimenti oyster culture, guided by microscopical studies, cannot be prosec without the aid of a practical oysterman, who not only secure right sorts of oysters, but who gives the practical data which th must deal with. The aid extended the investigator, through Mr. Mott's enthusiastic faith in the ultimate success and val these researches, and his untiring, skillful and self-sacrificing la in preparing the field apparatus, have been invaluable.

The small appropriation asked for did not contemplate any w for the cook and necessary helper, who must be present at this tion whenever the scientist is at work, much less any salary fo investigator himself. As Mr. Mott offered his services free, these investigations being brought under the regular work o Biologist of the Agricultural Experiment Station, the limited a priation was available for paying traveling expenses of the in gator, wages of laborers for digging and construction, expense lumber and other materials, and cost of provisions and ute The microscopical apparatus was supplied from the Biologica partment at New Brunswick.

This appropriation, economically spent, served to pay fo maintenance of the Mott Station for six weeks of occupancy; a addition, by repairing a dilapidated oyster-house and utilizin top of a yacht's cabin, there have been "established" two build one used for an oyster laboratory and the other for com kitchen, dining-room and dormitory, called "Hotel Bivalve." frontispiece of the report of the Biologist.

buildings and their equipment, two rather extensive nstructed (one under roof), and a large floating tank and prepared, which were used to receive the oyster fry e ready to "plant."

re legislatures renew the annual appropriation, it will le to establish oyster experiment stations at other long as the present Station offers sufficient facilities, geously be used in discovering the fundamental prinlerlie artificial oyster propagation, which would then supplemented at such secondary stations.

vever, be patent that, with the small appropriation we ment of the Mott Station is crude and incomplete. In ct, the most pressing need of the immediate future is a or floating laboratory, which can be constructed in a r a moderate sum, and will serve with greater conas hotel and laboratory, with the added advantage of abling the investigator to reach parts that are now ccessible to a laboratory on land to study the oyster on the natural beds as a guide to artificial propagaaboratory would take the place of several stations upon the coast that can be reached with such a boat. This nended to the attention of those interested.

Vork of the Season at Mott Station in General.

ent section we give, in chronological order, a journal experiments conducted at the Mott Oyster Experiment the summer of 1901. In the present section we shall glance at the work and its results.

June 21st, and on that day, as on each subsequent Biologist was at this Station, one or more experiments aising oysters from the spawn. The spawn of Amerimust be remembered, does not consist of young oyster case with the oyster on the European Atlantic shore. the ocean the oysters are of two sexes. When the ") of the female and the sperms (or "milt") of the ome "ripe," the very numerous and very small parg this "spawn" are shed into the water by the indi- It is in the water that the eggs become fertilized by l then undergo a development which transforms them, swimming "fry," and later this "fry" settles as

nearly-invisible "spats" upon shells, etc. The details of thi velopment were treated in our report last year, and subsequen tions of the present report treat the subject still more specificall

In artificial oyster propagation it is necessary to work i spawning season, procuring the oysters absolutely fresh, and opening them to decide, first, by the general appearance, wl they are "ripe," and secondly, by microscopical examinatic determine the "sex" of the spawn. Then the "male spaw put into a tumbler of water and the eggs are added, the whole kept stirred so that the eggs shall not settle in the bottom. Aft minutes or so the dishes are set aside, to allow the eggs to settl after about twenty minutes the milky fluid containing sperm light eggs and other *debris* is poured off, and new water is a then the washing of the eggs may be repeated, to "clean" still more. Such an operation is termed "fertilizing" the egg all the eggs that have been in proper condition to receive a will soon begin developing. This development can be watched the microscope. After about an hour, more or less, accordi the temperature, the eggs, which, as they came from the oyster irregular or elongated in shape, and soon after fertilization b "round" (*i. e.*, spherical), will now be seen to have one or buds on them, as if little eggs were attached to larger ones. developing egg pinches off a part of itself, but this part re sticking to the egg. The part pinched off in turn becomes stricted into two smaller globes, and new buds are pinched off side, so that after a while the egg has the shape of a little mul See Figs. 1, 58, 94, 96, 105 to 116.

After five to eight hours this mulberry mass begins to spin a (rotate) and finally to swim; and then, as all the eggs that c develop remain lying on the bottom of the dish and undergo d position, the water containing the lively embryos or "fry" is p off and the sediment is thrown away.

These operations must be repeated with every lot of spawn ized in order to obtain a lot of fry. The fry, after about five develop a two-valved shell, and then they seek a place to settle on. They must be put into a place where the water contains fine particles of food, and clean shells on which to "set," in to attain further development. The little swimming fry are as as the finest dust, and have but little power to swim. They ar ried away by the slightest current, and it is evident that if we

and raise them, they must be put into some enclosure
nnot get out.
ires we experimented with were two in number. In the
arvey (boat) was half filled with sea water and floated
ear the oyster station. In the second place, a tank 16
de of pine planks, was also half filled and floated in a
a shed. The water could freely run in and out of the
e tide. The tank was so made that water could enter
without losing the fry. This was effected by making
e tanks double, with a wide space between, filled with
he double ends were perforated with aügur-holes, and
retained by lining the perforated boards with cloth.
at entered the tank was free from mud and small
might eat the fry. It was also, unfortunately, free from
It is needful that the water in such a tank shall stand
to allow the microscopic plants to breed. The fact that
made of "new" pine planks, probably, also influenced
hat it could not support oyster food.
ttle spat developed on the shells placed in this tank,
so slowly that for a time it was thought to be dead.
l likely have become properly seasoned by next sum-
until then can its efficiency be known.
r hand, the water in the garvey was unchanged from
d it became "thick" with microscopic plants, though
ese could be used as oyster food. Several spat were
d to the shells in this receptacle, and they grew very

d garvey had received each week the spawn-lots that
ted during the week, so that it is likely that these spat
ly raised. But, unfortunately, two serious occurrences
from properly experimenting with these tanks. First
e earlier spawn lots raised in our dishes had the proper
the shell stage, and these tanks were not ready to
until it was too late. It was a curious fact that, though
lots of spawn were artificially started after these tanks
hey all failed to reach the shell stage. About a dozen
vere planted in these reservoirs before they reached the
cause they were dying in the dishes wherein they were
as at first thought that death was due to the fact that
itions in the dishes were unfavorable, therefore they
nted into what were supposed to be more favorable

quarters. But a careful study of all the data of the summ experiments has convinced the biologist that these fry could not under any conditions. Possibly one or two out of a million m live, but for practical purposes they were an "enfeebled folk."

The second serious occurrence which prevents our concluding these spat were artificially raised was the fact that at one of heaviest tides both tank and garvey became so much tilted that s of the outside water ran in over the top. Now, this outside wa in all probability, contained some fry, as the creek is lined oysters. No natural "set" regularly occurs here, and that fact be due to two causes—first, that the "plants" are largely south oysters, which, though they become very "spawny," probably not produce viable embryos in northern waters, and secondly, water is so full of sediment there is no clean surface for the fr fasten to. At any rate, the fresh poles put under the tank to ho up when the tide runs out received a "set." This "set" may course, have come from oysters artificially propagated and po into the creek, but any such accessions are small, compared what nature can produce, if, as is likely, most all the planted oy spawn naturally.

Even if the spats found in the tanks came from artificially-fertil oyster spawn, the fact that millions of such spawn were placed in tank and only one developed, would seem quite discouraging, u we refer the poor result to the fact that the artificial fry la strength to survive.

The work of the summer is not to be judged by the results of tank experiments by themselves. These are but a link in a seri results, all pointing to one truth, viz., that we have been under domination of a wrong theory during these past years. We tacitly assumed that, when we fertilized an oyster egg and it see to develop normally to the fry stage, it would continue to to adult age if no enemy killed it, and provided it were g proper food and water. Nothing can be further from the truth. there is one teaching of all our oyster experiments that stands boldly above any others, it is this, viz., that when we have a lo normally developing oyster eggs, that fact is no guarantee that t eggs will live the limit of oyster life. Whatever may be the u death rate among naturally fertilized eggs, it is certain that arti ally propagated oysters show an extraordinary "infant mortalit It is known that only one of a million (or more) of oyster fry reaches adult age on a natural oyster bed, and that fact has b

uming that the young were eaten or failed to find a But if in artificial fertilization an egg may be fertil- at various stages in the development, does not that cases must occur under natural conditions?

ain years when no set is observed, and there are en the spawn of oysters is ill adapted even for tilization. There have been climatic conditions, or iversal influences, at work that have operated to inferior quality. Fewer eggs are spawned; those viable even when fertilized, or the amount of spawn below the limit needed for successful impregnation. st year that "if a certain bulk of eggs be diluted , and a bulk of sperms, one five-thousandth as great, gs will fail to be fertilized. The best results occur diluted one thousand times and a bulk of sperms of that of the eggs be added."

size of an oyster egg can contain approximately d for the best results 120 sperms are needed to gg, in a quantity of water one-fiftieth of an inch in t the one-thousandth part of an ordinary drop of very drop of water over an oyster bed should contain for the successful fertilization of the eggs spawned

ical researches this past season have tended to cor- what was thus shown quantitatively by experiment. not be true in all cases, it is quite probable that, ster egg cannot be impregnated simply by coming a sperm. And it is certain that the sperms do not out and seek the egg. They simply lash their tails accident they strike an egg, if the egg attracts them, on to the surface, and then they try to penetrate . Each egg may be covered with hundreds of such a long time, in vain, to penetrate. There is but he shell is open where the sperm can enter. When enetrate, it is due less to its own efforts than to the draws it in. Then the other sperms cease to be comes changed in some manner, and they drop off,

al studies have plain, practical bearings upon the problems in oyster culture. We showed last year rtain oysters we got a greater percentage of develop-

ment than when the "crossing" was with other individuals. is in line with our general conclusion., viz, that the fry have degrees of viability. As yet, we are unable to tell why there difference; nor can we from present knowledge predict from an nation of the spawn, or from a knowledge of the history spawners, whether the offspring will be vigorous enough to adult age.

It becomes imperative, therefore, to give a minute study microscopical characters of oyster eggs; while this is a tediou and will require a long series of investigations, it seems plain writer that there is no other way out. That is the principal why the present report is almost entirely confined to this a the subject, though only in a general and introductory w more precise investigations will suggest themselves for futur Such microscopical investigations can be supplemented by ments of an apparently more direct and practical nature. Th oysters from different regions, or the "natives" in the same may be variously crossed and the results noted. But the mic cal or theoretical researches are likely to be necessary and t the most "practical" in the end.

The problem of scientific oyster propagation from artificia tilized spawn, when fully solved, will doubtless offer import vantages to the oyster culturist, but it is so complex that it be readily nor immediately solved. A larger knowledge of t logical facts relating to the life of the oyster and its eggs is ne before much practical headway can be made.

Sec. 3. Description of the Oyster Egg, Its Fertilization and Development.

Oyster eggs have an average diameter of one five-hundredth inch, and are therefore individually invisible to the naked eye, when many of them are together (yet not so many but t spaces between are at least equal to the diameter of an egg, a form only one layer on the bottom of a small amount of wa watch crystal) they appear as fine particles of dust if p lighted from above and the background is dark.

When they are first taken from the oyster, and spread o glass slide, and viewed with a microscope, they are irreg shape, but in general they are pear-shaped, being elongated, a pointed and a large end. Figs. 1, 2.

re left for a time in sea water, even when not fertil- change their shapes, becoming at last spherical. n native oyster eggs are more globular from the e eggs of southern oysters. Inside of each egg at obular body or sac, which appears very clear, while portion of the egg is more opaque, due to the pres- s small granules of yolk material. The clear body leus, and within it, near one side, lies another and be, as if the nucleus had itself a nucleus; this is Besides the nucleolus there are several granules is. They are composed of a substance called chro- of these granules are always present in a fixed f all nuclei, not only of the eggs but also in the r cells of the oyster's tissues. They are called See Figs. 18, 26, 29, 36.

called because it stains readily when a dye like car- to the egg. But there are several kinds of chroma- nucleus are chromatin granules that are not chromo- these are at least two large grains that contain can be gradually transformed into a clear substance n. In the nucleolus, also, there is a great deal of is also transformable into hyaloplasm. Fig. 29. nufactured there in considerable amount, and is the cell. Some of the chromatin grains in the d in the nucleolus. A good many of the chromatin leus escape out of the nucleus into the protoplasm he nucleus, and which is called cytoplasm. In the of these chromatin grains become transformed into t they still retain the power of being stained. They be used as food for the protoplasm of the embryonic

otoplasm" is one designating the different substances m and nucleus are composed, including both hyato- ious sorts of chromatin. But the material of which e made is called deuteroplasm.

material or deuteroplasm is made from a special n known as chromatin, originating in the nucleus. itself made from the blood serum or lymph of the ks out of the blood system of the oyster, into the ined to become eggs.

Part of this blood serum or "food" of cells may possibly be transformed into protoplasm of one sort or another without first pa through the chromatin stage, but it is certain that most of the matin, aside from that in the chromosomes, becomes sooner or transformed into different sorts of protoplasm, both inside of anc side of the nucleus. Yolk grains represent simply a storage of chromatin for future use. The various bodies or grains of chron and hyaloplasm, etc., float in a sort of "sap" or juice, which co of water holding salts and some proteids in solution. Doubtles sap contains in solution, materials that have been made by the matin (and other protoplasmic action) inside the egg cells, as w the materials in solution in the lymph absorbed from the oyster

The egg is surrounded by a "shell." This is a very thin brane, like that around a "yolk" of a hen's egg. It has a preciable thickness, except at the small end of the oyster's egg. the shell is not only very thin, but frequently is drawn out funnel, and is either ruptured or has a natural opening (microp See Fig. 26 *e. f.* The query arises, if the contents of the egg c of a sap containing granules, why do they not flow out throug micropyle? This leads us to consider another constituent protoplasm. The most prominent part of the egg consists material to which the term protoplasm has been applied especially. This material is nearly as clear as hyaloplasm exists in two forms, first as a compact, jelly-like substance second as a meshwork of fine strands, fibers, sheets and bubbles sap is held in the finest pores and spaces of the compact protop but in the interior of the bubbles and between the meshe fibers it is held just as water is in a sponge. This protoplasn remarkable powers of self-movement, and it can change its con tion from the compact form to the fibrillar form or to the bubble It can make a wall around a space, and so it can hold content like a sac. The surface of the egg just beneath the shell cons a thin sheet of compact protoplasm, so that were the shell str off the egg would still retain its shape. In fact, the proto itself determines the shape of the egg.

The "network" of protoplasm exists in the interior of th and is directly joined to the outer sheet (ectosarc) of protop This protoplasm also forms a wall about the nucleus, and insi nucleus there is also a network of protoplasm of a special The nucleolus itself has no wall, but consists of solid hyaloplas which chromatin granules are distributed. The chromatin gra

the yolk grains of the cytoplasm, are held in the spaces of the protoplasm.

, and most of the chromatin grains in the nucleus, the side of the nucleus which is next to the pointed Figs. 21, 24, 27. There is another body present in ignificance and origin are more obscure than is the arts that have already been described. This body cial sort of non-stainable protoplasm, which usually the outside of the nucleus at the larger end of the ry frequently present on the other side of the nucleus, has other locations. It has the power to divide into e two parts lie at opposite poles of the nuclear globe. ry extraodinary changes in form in connection with of the egg. See Figs. 15, 23, 24, 29, 30.

first leaves the oyster the protoplasm of the ectosarc receptive point at the small end of the egg; into this s, and the protoplasm, rejecting other sperms, gradu- o the interior. Meanwhile the egg becomes globular ickens and closes up over the place where the sperm igs. 29, 30, 35, 36.

n our experiments usually did not become attracted on as they came into contact with them. For several ing ten minutes) after sperms reach the vicinity of ce about, lashing their flagella or tails in all direc- g no particular attention to the eggs. Occasionally the egg-shell with its flagellum, and sits wagging its the water, away from the shell. One or more may es to the pointed end of the egg. After ten minutes, by preconcerted signal, there is increased activity ms near the egg (within one-thousandth of an inch); in a few seconds the entire surface of the shell is uggling sperms, as if, like drowning people, they were heir lives. And that is just what they are doing. re or fewer, that can touch the egg, only one enters hers, after hanging onto the shell awhile, lose their ent; they die and drop away. Only the sperm that eptive spot has been chosen. The shell, perhaps, in tecting the protoplasm from undesirable contacts, the purpose of preventing the entrance of more than e Figs. 32, 33, 34.

ate of the sperm that has entered? No sooner has a

sperm been received than the nucleus seems to dissolve. Fig
43. The chromosomes at first stretch out into long, thin-b
threads, that soon contract again into a compact form. Fig
Meanwhile, the other chromatin becomes transformed into non-
matic substances, the nucleolus disappears, the wall of the nu
becomes irregular and faint, the clear bodies in the cytoplasm be
peculiarly branched or star-like, with rays, the ectosarc shrinks
from the shell, and the shell is thrown into wrinkles, especia
the small end of the egg or its corresponding hemisphere. Fig
47. Meanwhile, the chromosomes have been transported t
large end of the egg and separated into two groups, just beneat
shell. Figs. 46 to 52. One group is then pushed out of and pi
away from the ectosarc, pushing the egg-shell up into a little m
that grows higher and higher. This is called the first polar glo
Meanwhile, the chromosomes left in the egg are divided int
groups again, and one of the groups is pushed into the base o
first polar globule, where it becomes separated off from the ect
as the second polar globule. Usually, only one projection is pr
which contains the first group of chromosomes at its apex an
second at its base. But sometimes two separate projections are
Fig. 59. The wrinkling of the egg is due to the active contra
of the ectosarc as it pushes the globules out, and sometimes the
tents of the egg burst out of the small end of the egg, where the
is weak. Fig. 54.

The chromosomes left in the egg are now only one-fourth o
original number. They stretch into long, coiled, thin threads
become enclosed by a nuclear sac. This new nucleus is calle
female pronucleus; it lies near the polar globules. Figs. 5
Meanwhile the head of the sperm that entered the egg has be
transformed into a nucleus containing chromosomes, and is c
the male pronucleus. Figs. 58, 60. While the polar globule
forming, this nucleus is dragged up towards the place wher
female pronucleus will appear, and the female pronucleus is
drawn towards the male pronucleus; so they lie close toge
usually near the large end of the egg. Figs. 61, 64, 68.

What is the mechanism which drags these nuclei, or their chr
somes, about? Evidently the one or two very active, clear bo
that lie next to the nucleus in the cytoplasm. Possibly the
which lies nearest the micropylar pole receives the sperm. V
the head of the sperm furnishes the chromosomes, the "neck
the "lash," or propeller by which it swims, and by which it e

a body called a "centrosome," which becomes the strosphere. (The astrosphere is the clear body of n, which become star-like, with rays streaming tions.) Those rays that stretch out towards the romosomes, become attached to the latter, and so ted by the contractions of the various rays. Figs.

at the other pole of the egg nucleus (next to the egg, where the polar globules appear) has a centro- nd it becomes transformed into an astrosphere. At divides into two parts (Fig. 46), that remain con- ridional strands of clear protoplasm, so that a figure ing a spindle, and so called. Figs. 48, 73. The chro- gg nucleus, after the nuclear wall has disappeared, to the meridional threads, and they are dragged e of the egg. where they become pushed out. It is of the astrospheres enters the first polar globule, owards itself half of the chromosomes. And it is e remaining astrosphere divides, so that one part he remaining chromosomes into the second globule.

the formation of these globules, the chromosomes ansformed into a female nucleus, attached to a single rosphere, just as is the male pronucleus, and in fact like. Fig. 67. It is natural to call the one nearest he female, as it was derived from the same nucleus ies. Otherwise it is impossible to tell "which is eyond our present purpose to discuss the general ogists have advanced to explain these extraordinary

ed simply with a description of the stages, which we on the plates accompanying this report. Suffice it are probably more complex relations (as yet not d) in the egg than would appear from the preced- We need hardly add that an egg (or for that matter ng being) is a marvelously complex piece of ma- rious bodies inside the eggs are only small grains, with the most powerful microscopes, and there are ins in the way, that to disentangle chromosomes rom other groups of granules in an oyster egg is a , which cannot be more than partially successful.

The two pronuclei, each attached to an astrosphere, now b
one nucleus, called a segmentation nucleus, and the rays of t
astrospheres become united to form the first segmentation s
(Figs. 75, 76); but the chromosomes from each pronucleus
for a while, each by themselves, so that the nucleus is at
double nucleus. Figs. 79, 82.

Each chromosome, after having been in a condition of a
beaded thread, shortens up into a compact grain and then spli
two. At the same time the protoplasm contracts around the
of the spindle and causes the shell to wrinkle at the large end
egg. Fig. 78. The two sets of chromosomes have, by spl
become four, and then one set of male and one of female ch
somes is dragged up to each end of the spindle, towards the
spheres, while the protoplasm becomes pinched into two cells,
the middle of the spindle. Figs. 79 to 85. Thus, each da
cell has received a nucleus, which is just like the original segn
tion nucleus of the egg, consisting of the same number of ma
female chromosomes, joined to an atrosphere. At first the c
formed are quite distinct (but their nuclei are indistinct in the
egg), while the protoplasm is active in division, but at last the
mosome become diffused and the protoplasm becomes passive
the nucleus becomes distinct, in the so-called "resting stage."
84 to 91. The two cells thus formed are called either segme
blastomeres; and when there are large ones and small ones th
distinguished respectfully as macromeres and micromeres. Th
cess of producing such cells by division of a single egg-cell is
either "cleavage" or "segmentation."

During the resting stage, the blastomeres are closely p
together or compact. During the active stage they are sharpl
tinguished. It is a peculiar feature of the oyster egg that durin
first segmentation there is separated more or less sharply by i
sphere of yolk substance. Fig. 80. It seems that the yolk
are crowded down into the micropylar hemisphere, and are sh
from participation in the division. This is true of all large
and is remarkable in the oyster where the egg is so small. Us
in small eggs, the entire egg divides into two. Owing to the
size of the yolk in the oyster egg, this yolk sphere appears
blastomere itself, so that during the first cleavage, the egg ap
to consist of three blastomeres. Fig. 80. But the normal rel
are restored during the resting stage, when one of the blasto

to the yolk, and so much larger than its mate. Fig. 94.

hile, the nucleus in each blastomere becomes trans-cond division, or cleavage. First, the astrosphere and forms a spindle; next, the nucleus dissolves; the chromosomes pass into the compact form and s on the equator of the spindle, where each becomes al parts; then the two groups thus formed become o opposite ends of the spindle, where a new nucleus ely to receive them. Then the cytoplasm becomes the middle of the spindle, and so we get four blas-which the yolk remains attached. Fig. 96 *e* This avage. The third cleavage repeats the same story, sults in the doubling of the cells, but this does not usly in all the cells, because those with the most slowly. Figs. 98, 99. When the fourth cleavage are 16 nuclei, each representing a cell. As devel-the cells split into smaller and smaller cells until ng fry is completed. Figs. 108 to 116. We shall rry the history any further. But we wish to speak ale" and "female" chromosomes are both present The nuclei divide, so that both sorts are always es not mean that the chromatin in the male chro-rent sort from that in the female chromosomes, but ne set is derived from the sperm, while the other egg. Therefore, in each cell of the developing asm from two parents. This protoplasm represents, nt as regards sexual characters, but also all other n be hereditarily transmitted, even those of *both* y or breed to which the parent belongs. This is t fundamental principle of the science of heredity he sperm is called the "male" cell because it is male" and it is *convenient* to use this term. The , though its parent is, and the embryo which it helps either a male or a female during development. e egg. The egg is a store-house of yolk-food for the ng embryo; that is why it is larger than the sperm. hromosomes that represent the parent oyster, and r in appearance from the chromosomes brought by two sets of chromosomes play equal and similar on of every cell of the body. The object of having

two sets is not that either one alone is *impotent* to direct develo
but that there is an *advantage* in uniting the qualities of two d
individuals or races in one individual.

**Sec. 4. Journal of Operations, 1901, at Mott Oyster Experi
Station.**

June 21st, Friday. Temperature at 5:30 P. M., 79° Fah.

Oyster lot I., from creek at Oyster Station, consists of eigh
(*A* to *H*) and five females (*a* to *e*).

Fertilized at 5:30 P. M., eggs of each female, by mixed sperm
males; also used sperms of each male successively on mixed
all females; and, finally, all males mixed, crossed with all
mixed. In all, fourteen experimental lots, all of which de
well.

Spawn lot 1. Union of all experiment lots (*A* to *H*) (*a* to *e*).
ming embryos separated from sediment next morning, and dist
into separate tumblers and flat dishes, and left to themselv
June 26th, when it was found that the bottom and sides of
of the tumblers were covered with spat in the first shell stage.
were dead, but many were still alive and free swimming. Th
and claires for planting these were not ready, and none re
alive after the seventh day.

June 27th, Thursday. Temperature, 80° Fah.

Oyster lot II., 4:45 P. M. Two males (*A*, *B*) and four fem
to *d*). Eggs were irregular in size, mostly rounded and c
granular, with *debris.* Female (*c*) had very few, as if spawn
One oyster, opened at noon, had its gonad full of gregarines.

Fertilized at 4:50 P. M., eggs of *a* to *d* separately, by mixed
and made a gross lot from all eggs of all females; five experi
lots in all.

Spawn lot 2. Union of first four experiment lots of oyster
Used for study. Polar globules formed at 5:30. Cleavage a
preceded by wrinkling of large or polar globule end of egg.
many eggs had reached four and eight-cell stages. Next morn
a fair lot of swimming embryos or "fry." Of these most a
dead by July 2d, five days.

Experiment lot No. 5 was so slimy it could not be cleane
eggs segmented and none reached the "fry" stage.

June 28th, Friday. Air 85° Fah., and water 82° Fah., at 9

Oyster lot III. Three males, *A* to *C*; eleven females, *a* to *k*.

slimy in water; parasitic amœbas in *g* and *h*; bac-
eggs very crinkly in *k*.

. M., eggs of females separately, by mixed sperms
eggs developed, except in *b*. Second polar globule
; first cleavage preceded by wrinkling of surface of
t 9:53; second cleavage at 10:05.

Jnion of best results of experiments with oyster lot
ed five days, having reached shell stage.

'ertilized at 3 P. M., eggs of *b*, oyster lot III., studied
seems to enter at small end of egg; kinetic figures
10, but at 3:47 no further development, due to lack
the cover slip.

ay. Air 96° Fah., water 90°.

Nine poor females (*a* to *i*), "Hog Island plants,"
hree (*j* to *l*) "naturals" from pond. No eggs in
s *l*. The oysters seemed to have spawned out in
were decomposing and granular. Fig. 3.

t 8:15 A. M., fertilized separately, *a* to *l* of lot IV.,
nentation shown at 9 A. M., and swimming "fry"

t 9:30 A. M., fertilized a large quantity of roe from
er so hot had to stop work. These lots were treated
July 4th, which date see.

perimented with killing and staining fluids. Sperms
yster serum and dried on cover slips, then treated
picric acid (saturated), corrosive sublimate (satur-
(20 per cent.), formalin (10 per cent.), acetic acid
cohol (95 per cent.) After washing, the preparations
picro-carmine (Ranvier's), borax carmine, hema-
s) and hemalum.

reagents on the moist eggs in watch glasses, but
good results as with eggs as sperms.

esday. Water 80° Fah., air 85° Fah., at 8 A. M.;

ysters of yesterday, kept in basket submerged in
rought from pond. Opened *A* to *C*, Hog Island
pond native." Sperms in *B* are active. Also
with gonad filled with gregarines. Opened three
emales (*a* to *c*) and one Hog Island female (*d*).

At 8:30 A. M., fertilized *a* to *d* separately. Best
and *d*.

Spawn lot 8. At 9 A. M., fertilized *a* to *d*, mixed.

Oyster lot VI. Brought by Watson T. Sooy, member of t
Oyster and Shell Commission, consisting of "naturals" from
river and James River "plants." Mr. Sooy experimente
ing Mullica native females with James River males. The
spent rest of day studying the eggs of *c*, *d* (lot V.) in seru
nuclear chromatin, at noon, is undergoing rapid and
changes, as is also the astrosphere. Fig. 13.

At 3 P. M. there seem to be two clear bodies outside of
contact with, the nucleus.

On adding water, there are visible two groups of r
(chromatin?) granules inside of the nucleus, each accomp
a nucleolus. After two hours some of the eggs assume the
form. Fig. 9.

July 4th, Thursday. Lowest temperature, 80° Fah., high

Lots V. and VI. show (as is usual) eggs in all and in
stages of arrested development. They were treated with pi
corrosive sublimate, nitric acid, formalin, acetic acid, and
respectively.

Oyster lot VII. Opened pond oysters. One contained gr
Females mostly in poor condition, with decomposing eggs
females, *a*, *b*, *c*; only *b* was good. Two native (*A*, *B*) and t
Island (*C*, *D*, *E*) males, of which *D* showed active sperms.

Spawn lot 9. At 12:30 P. M., fertilized mixed lot eggs b
sperms, *D*, *C* predominating.

Studied effect of reagents on eggs of *b*, lot VII. Nitric ac
nucleus to undergo amœboid contortions and even to burst,
chromatin is extruded at the micropylar end of egg. Or th
be simply extrusion of cytoplasm at this pole, the nucleus r
intact. Fig. 54.

Formalin also causes nuclear distortion, but less bursting

Eggs unfertilized of *b*, left three to five hours in sea water,
nuclei, become spherical, and on treatment with contracting
like alcohol, &c., extrude a globule at one or at both poles.
with picro-carmine, the nucleus is found to contain delicate,
chromosomes and dissolved nucleoli in quite a number of ca

July 5th, Friday. Temperature is 84° Fah. at 8 A. M. a
noon.

Oyster lot VIII. Eighteen Hog Island and two native oys
the pond, equally divided between the sexes, thus, *A* to *I*, *J*,
i, *j*. July 9th, all had died.

At 10:15 A. M., fertilized, *a* to *j* mixed, by *A* to *J* d by July 9th.

dy of effects of reagents : Acetic acid acts much like g extrusions at one or both poles of eggs, and deform- cleus. Fig 22.

imate causes shrinkage of the cytoplasm and wrink- nembrane, but the nucleus remains normal.

uses least deformity.

sday. Temperature, 80° Fah.

25 P. M., clam eggs, and secured an abnormal develop- n looks as if not yet ripe. Next day had swimming ," which were prepared for mounting by killing with ate and staining with picro-carmine.

Wednesday. Temperature at 7 A. M., 71°; at noon,

Fine lot of pond oysters filled with spawn, viz., two and *a*, and thirteen natives, *B*, *C*, and *b* to *k*. Sperms *C*, and eggs very fine except in *b*, *e*, *i*.

At 12:30 P. M., fertilized mixed *a* to *k*, lot IX., by od development of the heavy eggs, but a great many ecompose. The fry are not very active, and many ng next day (during which some were planted in July 12th no live ones remain. Having ascer- o-carmine gives best stain, we try its power, following , upon serum eggs: After alcohol, good ; after iodine, r sublimate, very good ; after formalin, good ; after e good ; after osmic acid, poor. The other killing or preparations.

ursday. Temperature, 86° Fah. at noon.

Fresh supply of oysters from same source as lot IX., garvey load over night.

At 11:15 A. M., put eggs unfertilized into sea water ; s got in accidentally. Used this and eggs of lot X. for n technique. Prepared series of slides, showing effect lization upon eggs left in opened oyster, and second, ntil 4:15 P. M., supplementary to the studies made .

iday. Temperature, 80° Fah. at 7 A. M., 78° Fah. ortheastern storm broke at noon.

Same source as lot X.

At 9:10 A. M., fertilized *a*, *b*, *c*, by *A*, *B*, *C*, lot elopment results ; swimming fry present at 2:30 P. M.

Oyster lot XII. Oysters freshly removed from creek. (?) Oysters had poor and granular eggs.

Spawn lot 14. At 11:55 A. M., fertilized samples of XII. Po velopment.

Continued studies in staining and mounting eggs of XI. and former termed "garvey eggs."

Techinque nearly perfected; most difficulty is to properly deh eggs before mounting, owing to moist atmosphere. Result s by treating eggs under cover slip, entangled in a film of cotton and using filter paper to draw fluids through.

At 6 P. M., stained embryos, lot XIII.

July 13th, Saturday. Temperature at 7 A. M., 73° Fah. I easter raging. .

So much moisture in air, it was impossible to mount the pr tions, so treated *debris* from lot XIV. with formalin and iodine, s with picro-carmine, cleared with acid alcohol and conserved th terial in vial No. 10.

Seems as if the developmental stages do not stain so readily unfertilized eggs.

July 16th, Tuesday. Temperature, 80° Fah. at 9 A. M., 88 in afternoon. Cloudy and muggy.

Oyster lot XIII. Five ripe males, *A* to *E*, and four females, not very promising.

Spawn lot 15. At 9:30 A. M., fertilized sample, and by 10:30 eggs were good because the polar globules were then forming 10:55 segmentation stages numerous. Planted in tank at even July 17th.

Spawn lot 16. At 10:40 A. M., fertilized *a* to *d* (XIII.), sepa by mixed *A* to *E*. Good development at 12:30 in *b*, *c*, *d*.

Spawn lot 17. At 10:55 A. M., fertilized *a* to *d* (XIII.) mixe placed some of these in life-box, but they fail to develop. not in life-box are also backward.

Spawn lot 18. At 1:35 P. M., fertilized eggs of *b*, *c*, *d* (XIII. made preparations of portions of the lot at each successive min twenty-five minutes, conserving them in vials Nos. 11 to 36 incl as see table at close of this section. The reagents used were i sublimate and formalin, in rotation ; and the stain was picro-car the "wash" was 70 per cent. alcohol, containing 3 per cent. m acid. All the operations were conducted in half-drachm, corke Preparations 11 to 16 were also mounted in balsam, on slid microscopic examination, though the humidity of the air mad

cate one. The sublimate specimens proving darkest, cleared, this reagent was ruled out in subsequent

dnesday. Temperature, 80° Fah. at 7 A. M., 88° Fah.

ess humid in the forenoon than in the afternoon, perating preparations, 17 to 36, at an average speed of ce.

. Four good males, *A* to *D*, nine poor females, *a* to *i*.
At 3 P. M., fertilized *a* to *e* (XIV.), separately.
all show good development.
At 3:55 P. M., fertilized *a* to *e* (XIV.), separately, d.
A union of lots, 19 and 20.
preparations were made in the vials Nos. 37 to 114, . being treated with iodine and the even Nos. with 40 to 99 are taken one minute apart, the others 5 to ee table at close of section.
stained with picro-carmine next day, July 18th.
ls, from 11 to 114, thus gives a complete series from ne time the swimming "fry" is developed.
s mounted at the laboratory at New Brunswick, and owed that iodine was superior to formalin as a killing on on technique.

ursday. Temperature, 76° at 7 A. M., 83° at noon, . Forenoon stormy.
Three ripe males, *A* to *C*, and four poor females, *a*

At 4:35, fertilized *a* to *e*, mixed, by *A* to *C*. Planted nk and garvey.
fertilizing eggs under cover slip and observing the Sperms added by irrigation soon become quiet from but on adding sea water, or lifting the cover, they Some eggs attract them more than others. The ot occur right away.
40 P. M., egg begins wrinkling, and no nucleus visible d first polar globule spindle seen at 4:55 P. M.; polar have been started at 5 P. M. No further develop- k of oxygen.
ggs round up and nucleus becomes faint in outline ter lying a half hour in water. Sperms added at h eggs, do not appear attracted.

July 19th, Friday. Temperature, 78° at 7:45 A. M.; 86°
A. M.

Oyster lot XVI. One ripe male, six poor females, selected "b
Many amœbas present.

Continued fertilization observations under the microscope. F
that sperms first attach themselves to eggs by their flagella and
try to bore through egg-shell with the "neck-piece." Gradually
draw the head closer to the egg, and at last become flattened ag
its surface.

Fertilized at 9:55 (?) A. M. Nucleus becomes faint at 10:07 A.
10:20 P. M., with wrinkling and formation of polar globules.

Fertilized at 11 A. M. The nucleus has disappeared by 11:35 P. M
wrinkling begun at 11:55 P. M.

Fertilized at 12:25 P. M. The sperms won't swim to an egg, but
be carried against it. At 12:30 P. M. the sperms reach the egg
12:43 P. M. they begin attaching to the eggs until some of the
are covered, as with a swarm of bees, thus impregnation prol
did not begin until 13 minutes after fertilization. The great s
prevents seeing which sperm enters the egg. The small end c
seems to attract most and earliest, but entire surface becomes cov
The sperms attach first by their tails.

At 1 P. M. the sperms are more quiet, and many drop away
the egg's surface. The eggs more round and opaque. They
begin wrinkling, and by 1:07 P. M. the first polar globule bec
extruded; completed at 1:13 P. M. The second globule is ext
at 1:18 P. M. The first cleavage spindle, with formation of a
striction between the yolk hemisphere and the germinal hemisp
and wrinkling of the shell of the latter is formed at 1:25 P. M.
second cleavage occurs at 1:46 P. M., but many eggs are sl
and pass into a quiescent state at 1:54 and 2:07 P. M., with
blastomeres closely united with the yolk, one, in fact, indisting
able from it, and at all stages more closely united to yolk tha
other.

Oyster lot XVII. One female from Elder Creek.

Fertilized at 2:30 P. M., eggs of XVII. Nucleus disappeared a
P. M.; the micropyle end begins wrinkling at 2:50 P. M.; first
spindle (?) at 3 P. M. Polar globules formed before 3:25 P. M.

August 28th, Tuesday. Temperature, 74° at 11 A. M.

Oyster lot XVIII. From creek at station. Two ripe males (*A*,
two "spawny" females (*a*, *b*) and six poor females (*c* to *h*)
rounded eggs.

At 10:50 A. M., fertilized *c* to *h* (XVIII.) by *A*, *B*. cent. of development.

At 11 A. M., fertilized *a*, *b* (XVIII.) mixed, by *A*, *B*. 75 per cent. undergo development. Wrinkling of s at 11:35 A. M., first polar globule appears at 11:40 globule completed at 11:52 A. M.; first cleavage, 0. Egg compact and nuclei visible at 12:17 P. M.

:35 P. M., eggs of *a*, XVIII., in life-box. Nucleus :52; polar globule formed at 2:07 P. M.; second P. M.

3:57 P. M., eggs of *a*, XVIII. At 4:07 P. M. the be numerously attracted; sperms still attached, but 4:20 P. M. Eggs take on bizarre forms; due to evapo- P. M.; put in vial 200. Show two globules at each in dying tissues of oyster do not round up as when

Wednesday. Temperature, 75° at 10 A. M. and 6 on.

. Kept in basket in creek. Six ripe males (*A* to *F*), emales (*a* to *d*), and two apparently better females

At 9 A. M., fertilized *a* to *d* and *e*, *f*, in two separate

few eggs developing in *a* to *d* and still fewer in *e*, *f*. 45 P. M., eggs of *e* on slide; eggs wrinkling at 9:52, g amœboid and obscure; sperms gather about choice

0:20 A. M. At 10:40 A. M., sperms gathered about lso fertilized at 11:20 A. M., sample of XX.

. Fresh from pond; very "spawny." Five good and seven good males (*A* to *G*).

At 12:25 P. M., fertilized *a* to *e*, XX., separately, by Did not care for them properly, being engaged in mixed eggs of *a* to *e*, fertilized on slide. Spawn lot velop, but experiments on slide gave good develop-

2:50 P. M., eggs of XX., *a* to *e*. Sperms at once fasten dantly; wrinkling at 1:02 P. M.

:20 P. M., eggs of XX. Polar globule at 1:50 P. M.; . M.; first cleavage spindle at 2 P. M.; most sharp at M.; compact again at 2:11 to 2:25 P. M.; second

cleavage at 2:29 P. M.; compact at 2:34 P. M.; third cl
2:53 P. M.

The eggs near the center of the life-box are far behind th
periphery, owing to lack of oxygen. In fact, only a sma
tion develop at all in the center, while nearly all devel
periphery of the drop.

Experimented fertilizing eggs of clams at 3:45 P. M., but t
were not active, though the eggs seemed ripe. Put sperm i
and eggs in 202. Eggs show well marked micropyle.

Fertilized at 5:40 P. M., sample of XX., opened at noon.
nucleus disappears and wrinkling begins; at 6:15 P. M.,
globule made; at 6:30 P. M. the second completed. At
put eggs into vial 203.

From the data presented in the foregoing journal, rela
rate of development of the different oyster spawn lots, we
lated the figures in the following table:

**Table Showing Number of Minutes After Fertilizat
Various Developmental Changes Occur in Oyste
Eggs at Different Air-Temperatures.**

DATE.	Temperature.	Impregnation.	Nucleus fades.	Shell wrinkles.	First polar globule.	Second polar globule.	First cleavage spindle.	Segments, sharp.	Segments, compact.	Second cleavage, sharp.
August 28	74	......	......	35	40	52	......	70	77	......
" 28	74	......	17	......	32	54	......	......	......	......
" 28	74	10	28	......	......	......	......	......	......	......
" 29	75	......	20	......	35	50	......	......	......	......
" 29	80	1	......	12	......	......	......	......	......	......
" 29	80	......	......	......	30	35	40	46	51	69
" 29	80	......	......	......	......	......	......	54	65	......
June 27	80	......	......	......	......	40	......	58	......	......
July 12	80	......	......	......	......	......	......	......	......	......
" 16	80	......	......	......	......	60	......	......	85	......
June 28	85	......	......	......	......	87	......	58	......	65
July 19	86	......	35	55	......	......	......	......	......	......
" 19	86	......	12	......	25	......	......	......	......	......
" 19	86	18	......	30	37	48	......	55	84	76
" 19	86	......	10	20	30	50	......	......	......	......
" 17	88	8	15	......	24	28	33	44	58	64
" 18	88	......	10	15	20	......	......	......	......	......
" 2	96	......	......	......	......	......	......	......	45	......

Remarks on the Foregoing Table.

ve been presented in the order of the height of the
id if the numbers be read in the different columns,
wards, it will be seen that they successively become
ustrating the well-known law that a higher tempera-
development. This law was also illustrated by a
ort for 1890.
owever, some irregularities in the present table that
ained :
es of July 16th, 19th, are slow at a high temperature,
August 29th show a remarkable rate of development
nperature. These results are to be explained by sup-
particular oysters used in the latter instance were ex-
gorous. We know from this and from previous re-
ggs of any one oyster do not all develop at the same
he vigor of all the eggs in an oyster rapidly declines
is removed from its native element. We also have
ence that oysters differ greatly in the character and
eggs, even when first taken from the water.
ve, in this and previous reports, shown that the rate of
dependent upon the supply of oxygen and the ex-
ne eggs are stirred and crowded.
arious events are not sharp ones, but each occupies
ginning and ending with imperceptible changes and
a climax gradually. It is difficult to observe the
lar phases in different lots of eggs.
temperature of the water is not equally a fixed num-
below that of the air. Also, the temperatures given
ing at the beginning of each experiment, and there-
ely the average temperature in each experiment.
ust all be considered in a set of experiments, in which
made, based on the variations in the rate of develop-
ndoubtedly, the rate of development is an important
gor and character of the spawn, and may, perhaps,
prominently in a practical system of oyster propaga-
re, studies along this line cannot be ignored during
mental period of scientific oyster propagation. It is
t season a more detailed and accurate set of experi-
oe carried out to determine the formula representing

the normal rate of development, under different conditions, in
that significant departures from this rate may be noted and
bearing on the outcome be seen.

**Table Showing Mode of Preparation and Age (in Minute
Fertilized Oyster Eggs in the Vials Prepared
July 16th and 17th.**

No. vial.	Reagent.	Age.	No. vial.	Reagent.	Age.	No. vial.	Reagent.
11	Iod.	0	46	Form.	27, 82	81	Iod.
12	Sub.	½	47	Iod.	28, 83	82	Form.
13	Form.	1½	48	Form.	29, 84	83	Iod.
14	Iod.	2½	49	Iod.	30, 85	84	Form.
15	Sub.	3½	50	Form.	31, 86	85	Iod.
16	Form.	4½	51	Iod.	32, 87	86	Form.
17	Iod.	5½	52	Form.	33, 88	87	Iod.
18	Sub.	6½	53	Iod.	34, 89	88	Form.
19	Form.	7½	54	Form.	35, 90	89	Iod.
20	Iod.	8½	55	Iod.	36, 91	90	Form.
21	Iod.	9½	56	Form.	37, 92	91	Iod.
22	Sub.	10½	57	Iod.	38, 93	92	Form.
23	Form.	11	58	Form	39, 94	93	Iod.
24	Iod.	12	59	Iod.	40, 95	94	Form.
25	Sub.	13	60	Form.	41, 96	95	Iod.
26	Form.	14	61	Iod.	42, 97	96	Form.
27	Iod.	15	62	Form.	43, 98	97	Iod.
28	Sub.	16	63	Iod.	44, 99	98	Form.
29	Form.	17	64	Form.	45, 100	99	Iod.
30	Iod.	18	65	Iod.	46, 101	100	Form.
31	Iod.	19	66	Form.	47, 102	101	Iod.
32	Sub.	20	67	Iod.	48, 103	102	Form.
33	Form.	21	68	Form.	49, 104	103	Iod.
34	Iod.	22	69	Iod.	50, 105	104	Form.
35	Sub.	23	70	Form.	51, 106	105	Iod.
36	Form.	24	71	Iod.	52, 107	106	Form.
37	Iod.	10, 25, 65	72	Form.	53, 108	107	Iod.
38	Sub.	15, 70	73	Iod.	54, 109	108	Form.
39	Form.	20, 75	74	Form.	55, 110	109	Iod.
40	Iod.	21, 76	75	Iod.	56, 111	110	Form.
41	Iod.	22, 77	76	Form.	57, 112	111	Iod.
42	Form.	23, 78	77	Iod.	58, 113	112	Form.
43	Iod.	24, 79	78	Form.	59, 114	113	Iod.
44	Form.	25, 80	79	Iod.	60, 115	114	F. I. S.
45	Iod.	26, 81	80	Form.	61, 116		

Sec. 5. Remarks on Technique.

le time was spent in trying about a dozen killing reagents taining fluids, and it was ascertained that the most illing fluid is a dilute solution of ordinary iodine in ide, as used to detect starch in micro-botanical technique. ins tried, Ranvier's picro-carmine gave the best results. t ways of applying these fluids were used. If one sim- preserve a considerable quantity of the eggs, the best e small vials with corks. The eggs are first washed, ether with sea water, are transferred by dropper into the they are allowed to stand five minutes, to settle. Most is then drawn off, and three to five drops of the killing ed. We used the various reagents stronger than is cus- use of the large dilution due to the water in the vials.

ten minutes (longer will not injure) the bottles are filled er, and, after settling, the water is drawn off as much as 60 per cent. alcohol is added, until the bottle is half allowed to act at least ten minutes, and is then drawn or four drops of the stain added to the sediment. After he bottles are filled with soft water, and as soon as set- awn off.

or ten drops of 60 per cent. alcohol, acidulated to the mit with hydrochloric acid, are added and allowed to minutes. Then the bottle is filled with water or weak as soon as possible is decanted as before. Again the lf filled with 60 to 70 per cent. alcohol, and this is taken 90 per cent. added in small quantity.

ay remain in this indefinitely. As soon as they are to he bottles are half filled with 95 per cent. alcohol, which, utes, is taken off rapidly and as nearly completely as its place given to absolute alcohol; the vials are corked er five or ten minutes the alcohol can either be removed, h xylene and removed, and pure xylene added. Do not te alcohol, or xylene and alcohol mixed, to moist air. the eggs, if properly dehydrated, become clear. The noved as far as convenient, and balsam, diluted with ently to render it readily lifted by the dropper, is added a tenth of an inch or so.

re now ready to mount, but may remain as they are ent to use. In mounting, a drop of the contents of the

bottle is lifted and placed carefully on the clean slide. It will sp
run off and soon become dry, leaving the eggs. Before it is dry,
a few fibers of absorbent cotton and lay them on the moist plac
the cotton may be placed dry on the slides, and the drop containi
eggs, be poured over it. Do not have very many fibers; ten or f
are sufficient. Now place a drop of ordinary fluid balsam o
eggs, and stir gently with the point of a needle until the egg
properly mixed with the mounting medium. Then cover w
clean cover. No. 1. Do not get more balsam on than neces
as the film may be too thick for high powers to reach the
Neither should the cotton fibers be bunched, but be evenly
tributed.

The slide may now be studied with water immersion lenses.
not try oil immersion until the cover has properly dried fast.
eggs are easily crushed by pressure and motion of cover.

In case a few special eggs are to be mounted, the prepar
should be treated on a slide from start to finish. Such a set of
should be in sea water, under a cover, held up by a few cotton f
or the eggs may, if numerous enough, be treated in a watch-cr
at least for several of the early stages, as described for the vials
then transferred to the slide and covered, as described, and the m
ulations completed there.

Small strips of filter paper are used to draw the various fluids
cessively through, beneath the cover. The reagents are applied
by drop at the opposite edge of the cover. The succession o
fluids will, in general, be like that used for the bottles. The pr
may be watched with the microscope, but the naked eye soon l
to detect, by delicate "schlieren," when the new fluid has rep
the old, in each case, and so the process is a litte more expedit
except when many preparations are made at once. Only two to
preparations can be run at once by this method.

Care must be used that, when dehydrating with absolute alcoh
drop of this does not stand outside the cover without being so
up, because, in a humid atmosphere, as is usual at the shore, it
almost at once become watery and produce trouble, if not with
xylol, then with the balsam following. This balsam shoul
diluted "xylol balsam."

The figures on the following plates have, in general, been origi
drawn in pencil, from nature, upon white paper, with a ca
lucida. Most of the figures were projected at 1,000 diameters,
viewed with from 500 to 1,000 diameters, when drawn free h

ore especially to the mounted eggs. The living eggs ield were more often drawn free hand and magnified) diameters.

hus produced have not been copied, but traced in ounted for photo-electrotype reproduction, being thus f, so that most of the figures (all the large ones) are lates of this report, magnified 500 diameters, and the nally.

een thought necessary, when dealing with so many ne object, to state the magnification in each case, the nation being thought sufficient.

yster egg is very minute, there is still enough yolk to render the delicate nuclear figures within the egg Many thousands of eggs have been studied, and awings made, from which those reproduced have been is way it was possible to see what features were com- accidental, to the eggs. But it is probable that some en represented which were only accidental grouping or at least, non-chromatinic aggregations of protoplasm, *is* on the egg-shell, etc. But it is thought that these ts have been well nigh eliminated.

hand, undoubtedly, there are structures present that and so are not put into the drawings; and thus they e. Still, the general results tally fairly well with the ave of maturation of eggs in general. Nevertheless, peculiarities that require to be carefully looked into, ortant points, where there is either doubt of the true or the links have been guessed; and it is evident that uesses may be erroneous.

eggs are in outline diagram and not artistically fin- ve shown only the significant structures and left out

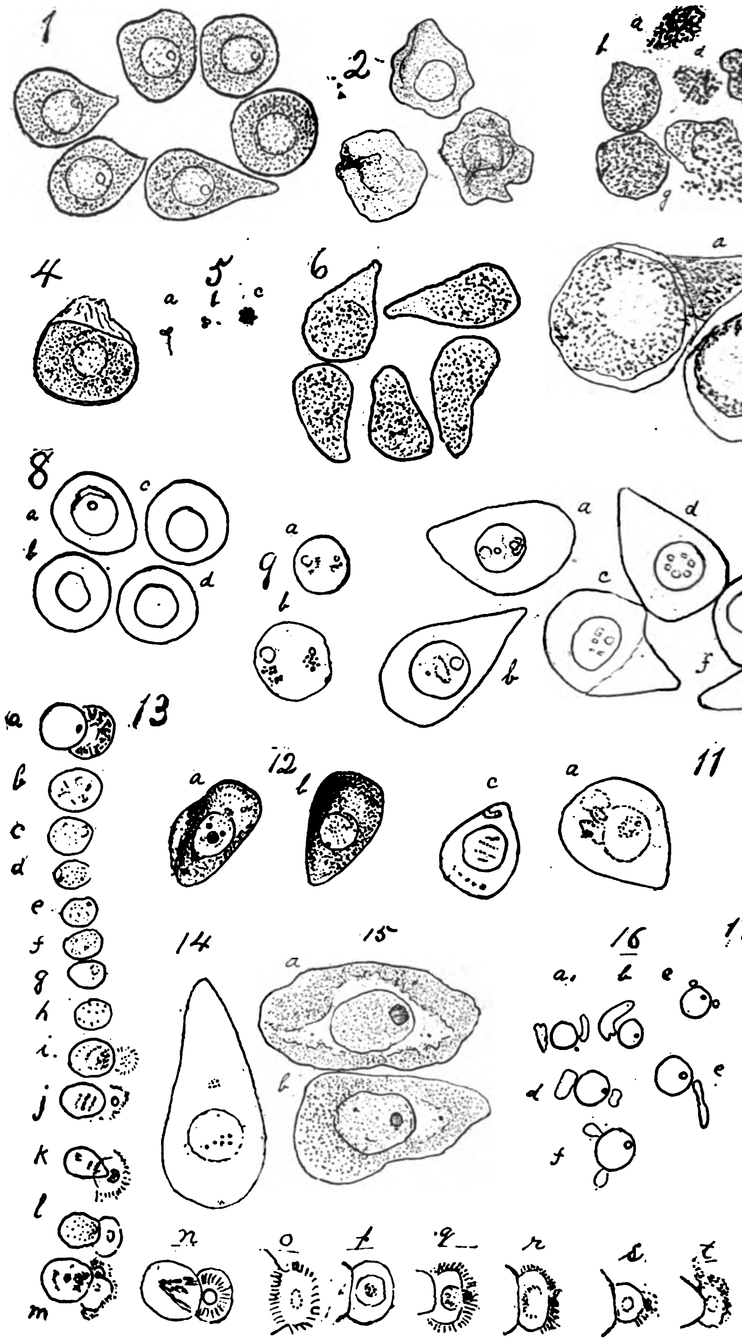

PLATE I.

PLANATION OF PLATE I.

CONSTITUENTS OF OYSTER EGG.

s in good condition, as seen under the microscope.
"native" oyster. They are irregular in shape, owing to the fact that they
gether in the ovary. After lying a short time in water they attain a more

or" eggs, showing the coarse grains of yolk, etc., which they contain, and
shell breaks easily and sets free these grains.
the shell membrane pulled out from the yolk and torn open at the apex.
an unripe male, showing how they are still attached to one another in

ggs from a southern oyster, which has been for several hours opened.
of the eggs is retained, but that the nucleus is becoming obscure.
e those of Fig. 3, but more highly magnified, to show that the outlines or
ve faded and that the yolk has shrunken away from the shell in certain

s like those at 1, 2 or 6, but drawn without the yolk grains, after lying in
they are like those of Fig. 6 it takes five or six hours to reach this result.
are fertilized, it takes only a few minutes. If fresh and unfertilized, it
th of time between the extremes indicated, for the eggs to reach the

rom eggs like those of Fig. 10. It will be seen that the nucleus contains
dary nucleolus, each accompanied by a group of chromatin bodies, pos-
There seem to be nine of these with the smaller nucleolus, and two groups,
the large nucleolus. In 9 *a* the units of the latter group are radially
of the nucleolus.
eggs from an oyster which has been opened for some hours, on a very
diverse figures the bodies within the nucleus assume. In 10 *b*, for
mosomes (?) have arranged themselves in an equatorial ring between the

he same lot as Fig. 10, showing that at the large end of egg *a*, and smal
plex figure, probably representing the astrosphere.
to those of 10 and 11, showing the activities of the astrospheres at the
ucleus. In 12 *a* the astrosphere at the large end of the egg is active, and
a row of bodies. Within the nucleus the chromosomes have arranged
vision.
wings of the same nucleus with the principal astrosphere, for 30 consecu-
ucleus without the astrosphere is shown in *b* to *h*, and the astrosphere
astrosphere itself has a nucleus, called the centrosome. In addition to
nters active in the periphery of the astrosphere, as see *m*, *q*, *s*, *t*, etc. The
egg nucleus goes through various evolutions, resembling those of cell
ver accomplish any division of nucleus, etc.
those of Figs. 10, 11, 12 and 13, treated with corrosive sublimate, stained
nd examined, mounted in balsam, showing seven chromosomes in the
anules on the small-end side of the nucleus, probably belonging to the
here, and two groups belonging to the astrosphere of the large pole of

ar eggs treated with iodine, stained and mounted. In *a* the clear pro-
heres lies at both poles of the nucleus, and each contains, apparently, a
one astrosphere is visible.
uclei, with accompanying astrospheric (clear) bodies, from the same lot
, at a later hour, and viewed in the fresh condition in their own serum,
e clear body, but probably ready to divide.
leus, seen for 20 consecutive minutes; same lot as Fig. 13. Only in *a* is
; in *b* the opposite pole of the nucleus becomes dissolved, showing that
e in its neighborhood, also. Temperature, 91° Fah.

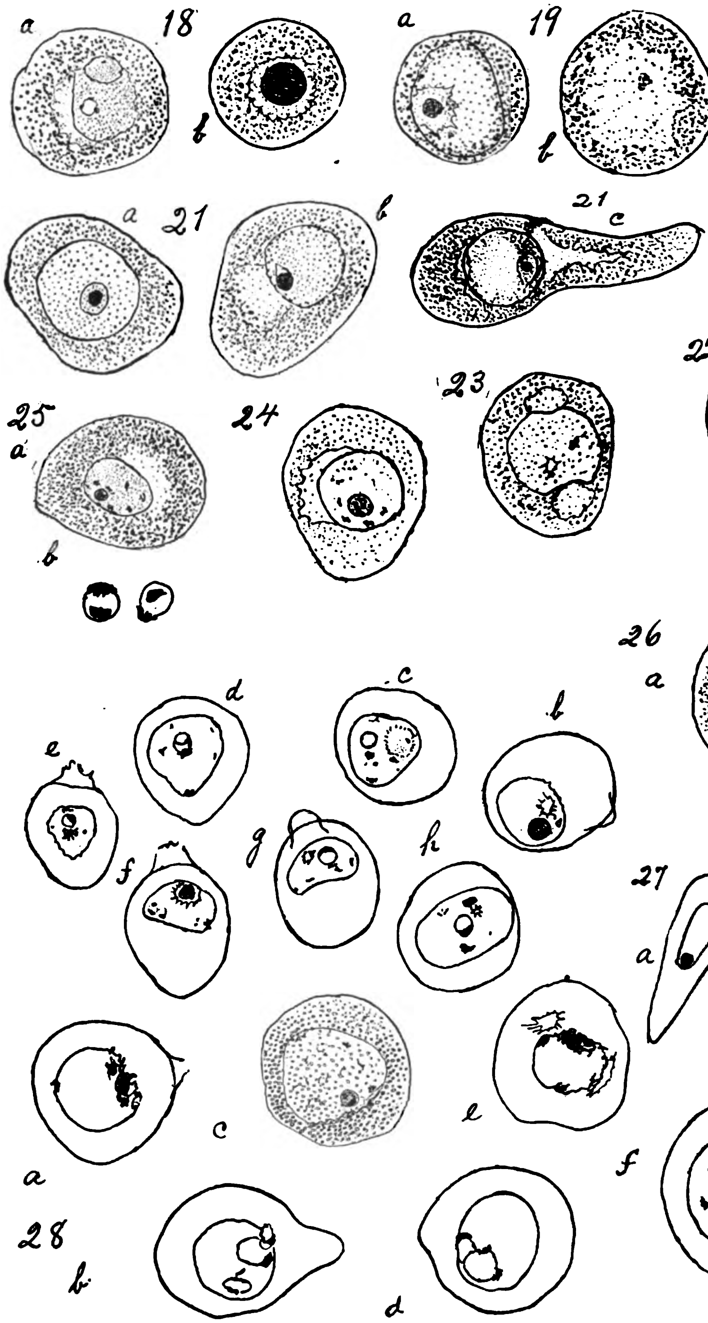

PLATE II.

'LANATION OF PLATE II.

OYSTER EGG BEFORE FERTILIZATION.

eated with iodine solution, stained and mounted, after lying four hours,
ater. In *a* we see the nucleus beginning to break up; *b* is an exceptional
ılt case to explain. It is supposed the chromatin has diffused throughout
ıcreased in amount at the same time; the latter body has swollen to an

sort of eggs, prepared with formalin solution, after staining and mounting.
olution has hardly begun, while it is nearly completed in *b*.
l from eggs that have lain five hours in water, prepared with alcohol,
armine and mounted in balsam. Two sorts of chromatin bodies are
ded, bent threads and the large granules apparently definite in number,
o determine just the exact number.
ee stained and mounted eggs prepared with iodine solution. These are
opened oyster, but the oyster has been out of water over night. This
astrospheric protoplasm, as in *c*.
showing globules at both ends, probably consisting of astrospheric proto-
ı treated with acetic acid under cover slip.
g, treated with acetic acid, showing shrinkage of nucleus at the poles
bodies. Oysters from which these eggs came had probably lain out of
her had been very hot.
esh oyster egg, treated with iodine and stained.
f egg as last, treated with corrosive sublimate. At *b* are shown two nucleoli
ıow how there is an internal mass of chromatin imbedded in, and an ex-
to, the hyaloplasmic body of the nucleolus.
rious eggs, drawn without yolk granules, prepared with formalin and
rmine. Only the more prominent and stainable grains of the nucleus are
ıadowy body in *c* is probably an astrospheric body, attached to the nucleus
ough possibly it is the large nucleolus expanded and dissolving. Several
nd *f* show an extraordinary micropyle.
" eggs from oyster that has been some hours out of water.
one and a half minutes after fertilization, treated with formalin, stained
e, drawn showing the yolk grains and the "reticulum" of the nucleus.
compared with the last, and with figures of unfertilized eggs that have
ıat have not been freshly removed from the water or have lain several
ill be seen that the presence of the sperms, though they have not yet im-
has already caused interior activities in the nucleus. The chromatin
re rapidly dissolving. The astrospheres are developing and the walls of
neighborhood are breaking down with pseudopodic projections. There
t but that some of the elements of the karyokinetic spindle, and possibly
re derived from some of the chromatin bodies in the nucleus.

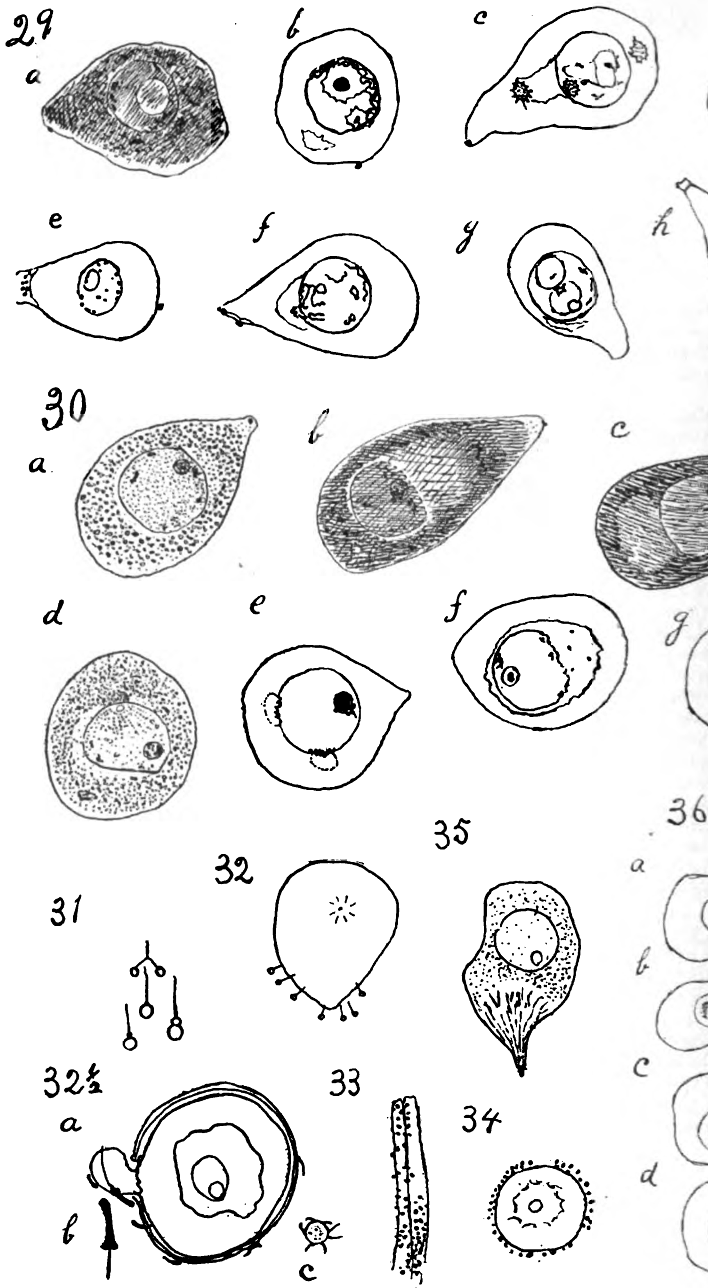

PLATE III.

XPLANATION OF PLATE III.

OYSTER EGG DURING IMPREGNATION.

ggs one minute after fertilization; treated with corrosive sublimate; stained ne; studied in balsam. In all, except *g* and *h*, one or more sperms are seen rface. In *e* there is a wide micropylar funnel, and here many sperms have e figures show that the nucleus is dissolving and the astrospheres are form- astrospheres are visible; in *a* and *e* none are seen. In the other figures one ent; *f* has probably the most advanced nucleus of the set.

imilar eggs (as in 29) treated with iodine. The darkly shaded *b* and *c* figures tive depth of staining; *d* exhibits the action of one of the centrosomes; in *e* ere has become two; in *b* and *c* we see the astrospheric protoplasm on differ icleus in the two cases; in *d* and *f* we see that at first this protoplasm forms a und the nucleus on all sides. It looks as though we had to do with three phere. Largest is the clear protoplasm; next is a nuclear sort of aggregate, leolar point in the center, called the centrosome.

sperms very greatly enlarged. In one of the specimens we see how the mature sperms split the flagellum, and so make two mature sperms.

tes how the pointed end of the egg offers the principal attraction for the the sperms attach themselves first by their tails.

f a clam after fertilization. Owing to some abnormal condition, the egg has lobule of very clear protoplasm at the micropyle, and the sperm that has ws clearly its flagellum. In the other cases, only the heads are visible as dies. At *b* one is drawn to a larger scale. At *c* is a small corpuscle, to which ve attached.

e of muscle fibers of the oyster, upon which many sperms have fastened. ne, stained and mounted.

as seen with a microscope, when the eggs are fertilized on the slide, and lip. After the proper lapse of time, nearly every egg, but with some excep- ered with as many sperms as possible. We have here shown only the optical

in the act of receiving a sperm at the pointed end. The apical protoplasm is freer from yolk grains than elsewhere, and it is evidently in some sort of

The same egg viewed under the microscope, at different intervals following sperm is shown at the pointed end, and in *d* has broken up into chromo- le. the egg chromosomes have been actively undergoing kinesis, but in this m lack of oxygen under the cover slip, the kinesis is abortive, and no polar iclei were formed. To the right of *c* and *d* are shown three successive views he uppermost one is a polar view.

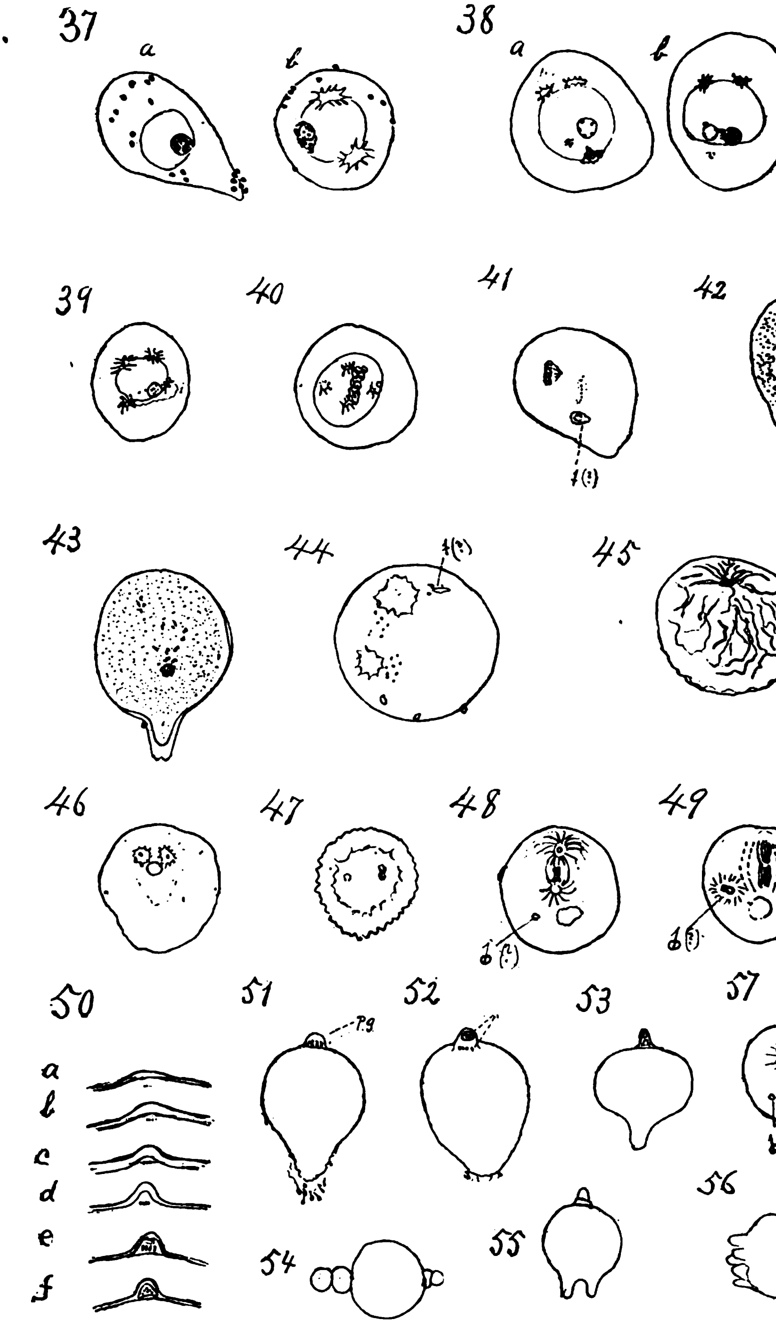

PLATE IV.

.PLANATION OF PLATE IV.

FORMATION OF POLAR GLOBULES.

Oyster eggs nine minutes after fertilization; stained; showing the sperms
ous parts of the surface and particularly the point. In *b* we see the nucle-
l find two astrospheres present. Unless otherwise stated, all eggs henceforth
ed. Those designated "living eggs" were, of course, not stained.
Similar eggs one minute later.
ly, four astrospheres are present.
matin rosette has formed in the center of the nucleus, twelve minutes after

matin rosette is traveling towards the surface of the broad end of the egg,
s after fertilization. Probably the body near the pointed end of the egg is

ve come before 40. It represents the nucleus dissolving, fifteen minutes after
romosomes are scattered as yet, and not gathered into a rosette.
mosomes are collected into a ring. The astrospheres did not show in this

of chromosomes. each with an astrosphere, are present. One or two other
, one of which is possibly the entered sperm. In that case the rosette near-
t rather than to the chromosomes. The chromosomes seem to be in groups
the nucleus before dissolution. Twenty minutes after fertilization.
nutes after fertilization, stained after treatment with formalin. The clear
g is present in branching and anastomosing plates that are much crinkled.
present [in a drawing. Their number and course have been symbolized or
ically by the lines. The middle of the broad pole of the egg is now drawn

e astrospheric spindle with the chromatin nucleus lying between the astros-
e surface of the egg, at its large end.
e living egg as soon as the sperm has entered, ten minutes after feritliza-
the nucleus is dispersing and the chromatin nucleoli are dissolving. The
thrown into numerous wrinkles and the entire egg is contracting. It is at
tion of Fig. 45 is established. This condition remains until the egg has

g five minutes later, showing the spindle which is to make the polar
atter of doubt which of the two remaining bodies represents the entered
t applies to the next figure.
spindle five minutes later. The central or chromosomic elements have
groups. The upper one will form the first polar globule.
ows successive stages in the formation of the bud on the shell, to receive the
ning, apparently, four pairs of chromosomes. These views are of the same
art, viewed alive.
vith the first globule completed, forty minutes after fertilization. A new set
gin at the small end of the egg and travel or extend upwards. The material
le is being pushed out; this takes but a few minutes.
ith the second polar globule completed. Note that the chromosomes lie at
containing the first globule, but this is not invariably the case in other eggs.
ith an extraordinarily prominent polar bud. The pointed end of this egg,
wn in so the egg can become nearly spherical, is being pushed out
vith two polar globules at each pole; the large globules at the small pole
e not real polar globules, but are protoplasm or yolk plasm, squeezed out
acted, to make the real globules at the (in this figure) right-hand pole.
e two false polar globules side by side.
has only one true polar globule, is budding a goodly group of false ones at
e egg.
iewed from the pole while the polar spindle is active, making the polar
many chromosomes there are, and just how they are divided to make the
not been determined for the oyster egg. The phenomena are so very
accurate observation, and the data from different eggs do not seem to agree,
servation has gone. Several independent counts of the chromosomes have
pers, but there has been most agreement on the number sixteen for the egg
eral laws governing these procedures in other eggs, we should expect that the
ontains eight chromosomes and the second four. But as these chromosomes
state of subdivision to a state of union. and *vice versa*, constantly, it is no
difficult task to ascertain the exact number. When they are numerous they
e another.

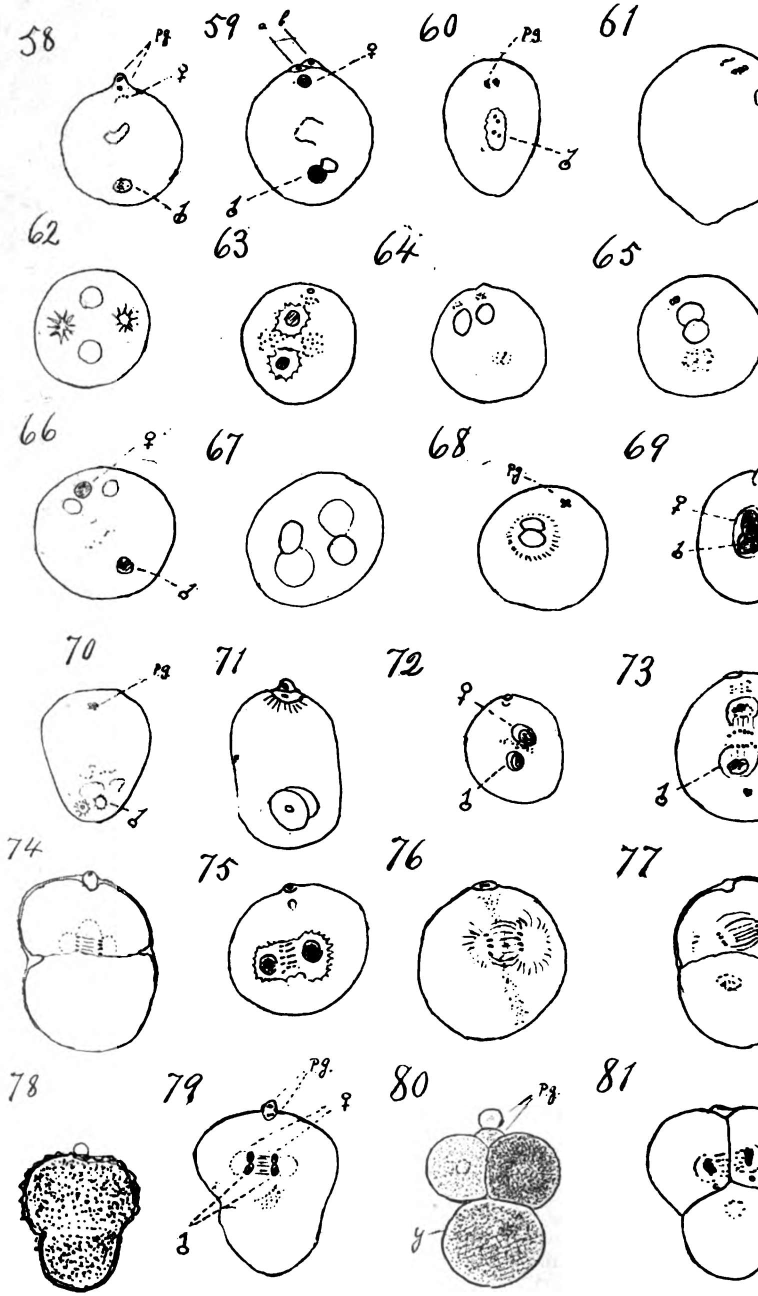

PLATE V.

PLANATION OF PLATE V.

UNION OF THE PRONUCLEI.

wenty-five minutes after fertilization, stained with picro-carmine, show-
bules, *P. g.* the female pronucleus (or rather its chromosomes), and the

the preceding on ly in that the chromatin of the female nucleus is diffused
lei are alike.
; two polar globules and a nucleus having four chromosomes. This is
the sperm, in which case only one polar globule is as yet made or, as
pronucleus has only two chromosomes at this stage. The nucleus along-
le is half of the original egg nucleus. When it shall have given up half
form the second polar globule, it will be the female pronucleus.
two pronuclei with their astrospheres. The other bodies in the egg are,
bules, or their equivalent; perhaps the polar globules are hidden on the

eres have taken position. to draw the two pronuclei together.
nuclei are nearly in contact.
ariant of what is shown in 61.
rosphere splitting into two, close by the two pronuclei.
male pronucleus with two astropheres; the male pronucleus has, as yet,
bed any.
ei, each with an astrosphere in a peculiar stage, in which all four organs
superficial appearance.
onuclei are enveloped by one mass of astrospheric protoplasm. The
lone is present, the first having been rubbed off.
howing that the pronuclei are really nucleoli.
perm at the micropylar end of the egg, becoming furnished with an
plain whether or not the female pronucleus has come down here, too.
pronuclei in close contact at the micropylar pole.
vo pronuclei dissolving, to make chromosomes.
spindle and chromosomes of the pronuclei. New astrospheres will be
de of the middle of the spindle, or else the spindle turns around and
tion spindle. Compare Fig 68.
mentation spindle. Note that there are apparently three astrospheres;
rhaps lost) in the yolk hemisphere. Possibly it has something to do with
m the germinal hemisphere.
n spindle, 36 minutes after fertilization.
the act of separating the egg into two segments. The chromosomes
the daughter groups of chromosomes.
, showing a marked division between the yolk and germinal portion of
Fig. 76.
w of a live egg during the process of starting division by the spindle, just
rinkles on the surface of the germinal hemisphere.
on of such an egg after staining, Note that each daughter nucleus con-
hromosomes, diffused in a body of hyaloplasm. The bodies on the sides
s probably represent the two daughter halves of the female pronucleus,
of the male pronucleus. There seems to be some evidence of a "yolk
esumably the relic of one of the pronuclear astrospheres. It is hoped
s will be cleared up by further studies.
w of a segmenting egg, one or two minutes later than Fig. 78. This is
eparation of the segmentation spheres or buds (blastomeres). Only two
t, corresponding with the two daughter nuclei of 79. The yolk sphere (*y*)
. It will soon reunite with the darker of the two blastomeres shown.
al view, a very few minutes later, when the nucleus and spindle are pass-
dition, so that the blastomeres are closer together, but the yolk is still
f separation.

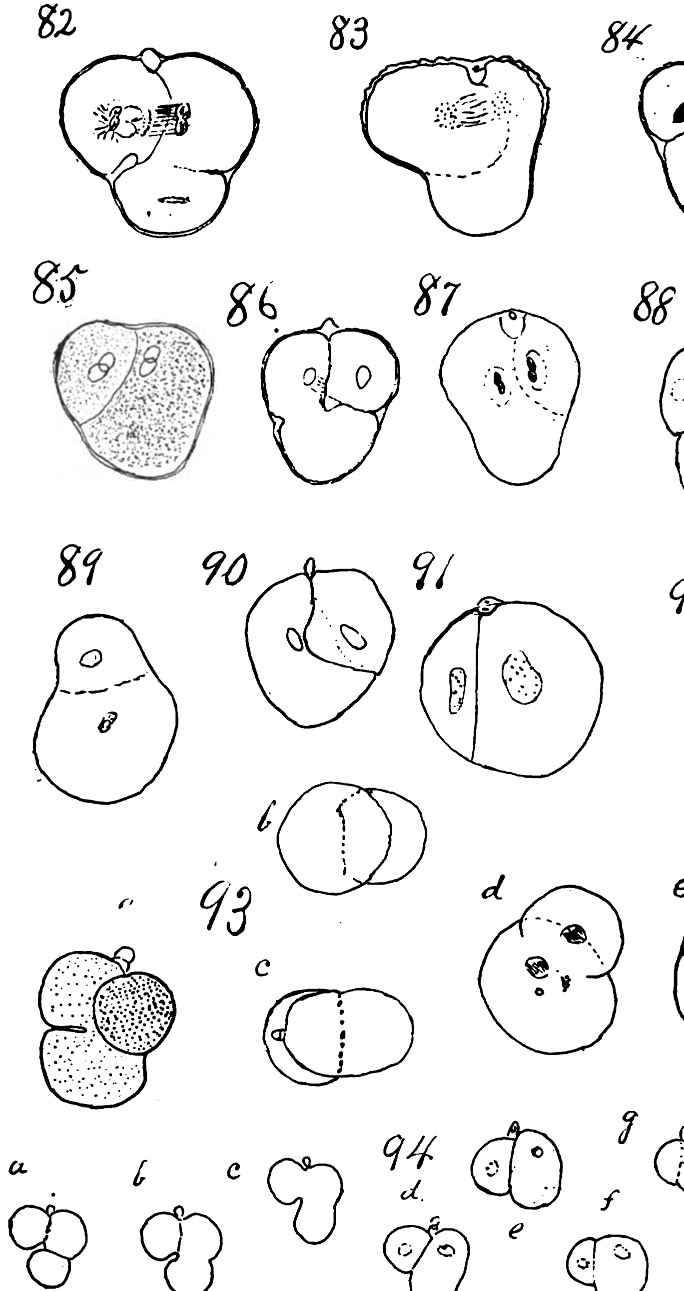

PLATE VI.

XPLANATION OF PLATE VI.

OYSTER EGG DURING THE FIRST CLEAVAGE PERIOD.

yolk sphere partly reunited to the macromere, the nucleus of which is
g stage. The nucleus in the micromere is still active, and its cell is
the yolk.
now a part of the macromere, and the micromere is partly imbedded in
arly in the resting stage.
has disappeared and the nuclei are in the resting condition.
the last, showing that the micromere is clearer than the macromere.
ews of eggs in stages corresponding to 84 and 85, but viewed from the

view of an egg nearly in stage, 88.
Eggs in various positions, and showing varieties of the "compact" form.
inuation of same subject as drawn from the living egg, and not so compact
illustrating the contracting effect of the reagents.
vs of one and the same egg, drawn while segmenting, and at intervals one
ning fifty-four minutes after fertilization, except *h*, which is five minutes
a is one minute after wrinkling.

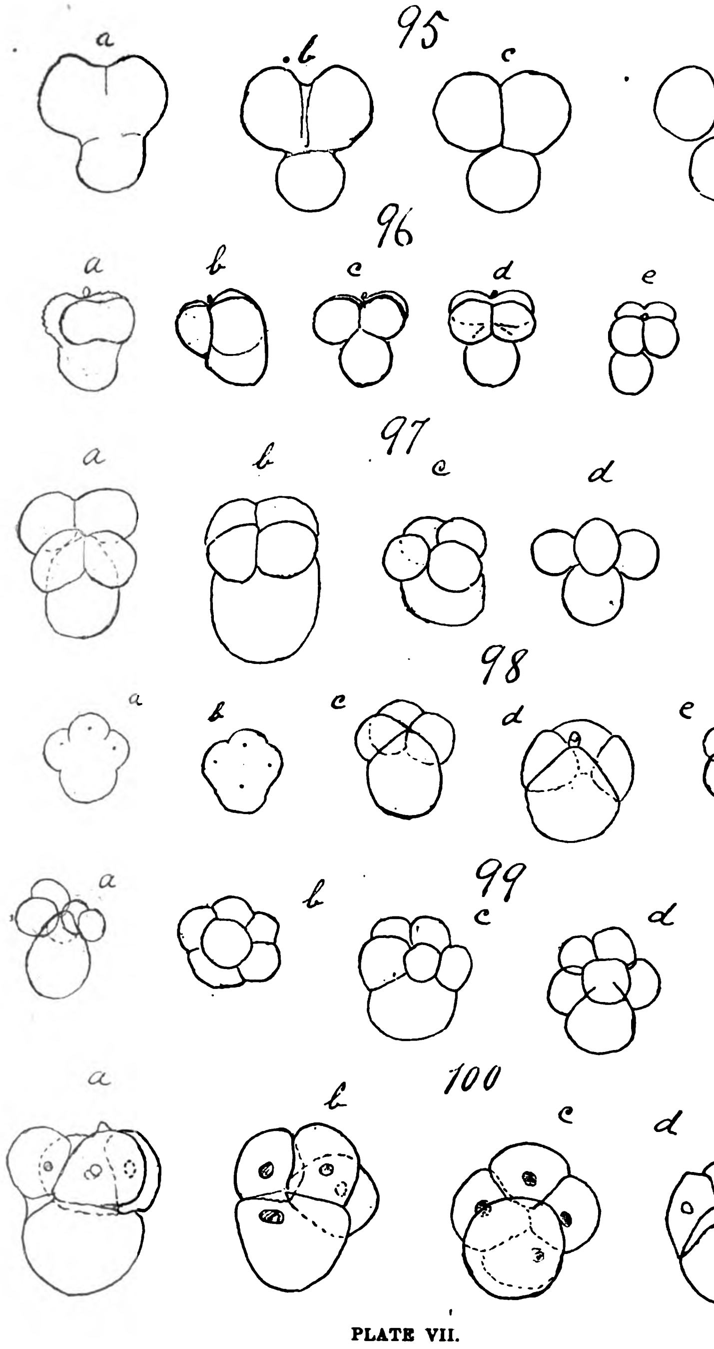

PLATE VII.

PLANATION OF PLATE VII.

YSTER EGG DURING THE SECOND CLEAVAGE STAGE.

stages in the formation of the first cleavage, that intervene between 94, when the development is slower, due to lower temperature. In 94 apsed after wrinkling, before form *a* was produced. In 95 the four stage by one minute intervals.

n the execution of the second cleavage. The series follows *h* of Figs. on another egg. Scarcely more than a minute separates these figures; e front, where the first micromere is situated. This has begun to elon- e macromere behind it also elongates and separates off from the yolk; from the side; *c* is a side view; *d* is a front view and *e* a later, side view t will be seen that apparently four micromeres are formed.

s eggs in various positions during this stage of development. In *d* and ew micromeres has joined the yolk, to make a new macromere.

s stages of compacting of these new blastomeres; *a* and *b* fit on to the ase of delayed division of the first macromere. while the other, not only leavage, but its daughter cells have begun to divide again. Such a case nuclei in five blastomeres.

s eggs with five blastomeres, viewed in various positions: *a* from side; de; *d* from in front.

egg with six blastomeres. This is the case when the first micromere first macromere divides but once, the former having passed the third he latter only the second. Note that these the first three cleavage planes endicular to one another.

stained and mounted specimens, corresponding to the preceding series, the living, active eggs. Drawings in Fig. 100 represent a magnification as Figs. 95-99 only 250 to 350 times. Were it not for the shrinkage pro- e drawings in Fig. 100 would be twice the diameter of the other figures.

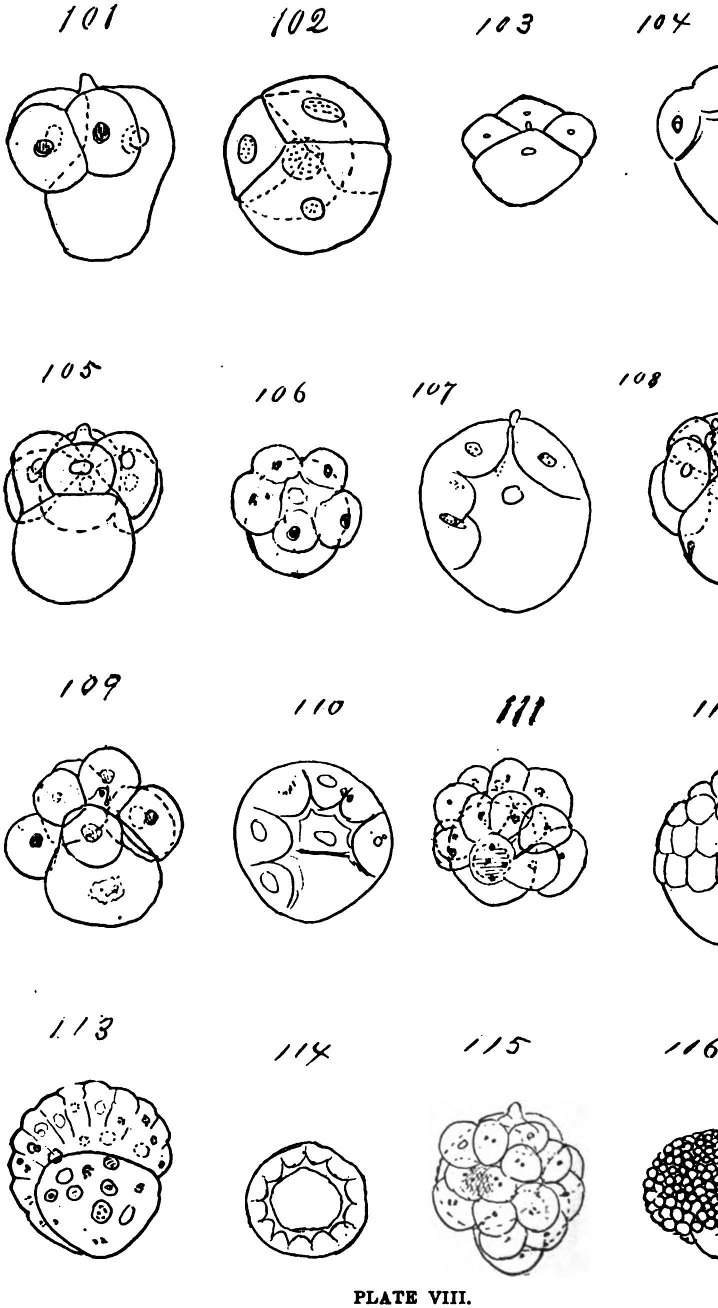

PLATE VIII.

'LANATION OF PLATE VIII.

STER EGG DURING THE LATER SEGMENTATION STAGES.

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of stained egg after the macromere has re-formed, after the second

e four blastomeres have become compact.
five blastomeres.
of egg, with six blastomeres.
f same.
ion of same after compacting.
w of developmental stage, with eight blastomeres.
d a half hours after fertilization, showing the micromeres beginning to
e.
ion at a slightly later stage.
nere is nearly enveloped by micromeres, which meanwhile are multi-
maller.
de of the micropylar pole is left uncovered.
ion at a slightly later stage (from side), one and three-fourths hours after
lei, seen apparently in the macromere, are those of the cells or blasto-
. projected.
optical section, a little later (compact).
nere is nearly covered.
ee hours after fertilization of egg.

PART II. CONTRIBUTIONS TO OUR KNOWLEDG BOVINE TUBERCULOSIS.

In this part of the report of the Biologist we present the tions made upon the College Farm herd and the Hospital Ba in continuation of our previous reports on these animals. T ings at the autopsies of two interesting cases are described, a abortions, and one of special tests with tuberculin, are give finally, an extended and careful set of temperature readin February to June, inclusive, observed on tuberculous anin their calves, concludes this report.

A careful and detailed study of these data and discovery ciples is reserved for future reports.

AUTOPSY OF NO. 18.

This cow had been tested four times. The first time, on ac to the herd, October 26th, 1898. The highest temperatur injection was 102.5°; the highest the next day was 102.5°. was young, a high normal temperature was expected, and admitted. Of course, the temperature record gave absolu evidence of reaction having occurred.

The second test was made October 19th, 1900. The hig first day was 102.3°, the next day the temperature rose to Clearly a reaction.

The third test was applied April 24th, 1901. The highest day was 103.0°—a suspicious "fever temperature." Next following the test the temperature was 106.0° and remained day. A very clear case of reaction.

Again, she was tested June 15th, 1901. Her normal tem was now 103° to 104°, or even higher. Next day, after inj tuberculin, the temperature was the same. The figures s "test" reaction, but we must consider the high normal tem as a physical symptom of advancing tuberculosis.

During the hot weather of June, 1901, this animal failed and it was determined to slaughter her. This was done, and made July 6th. Her appearance at this time was typical of stages of tuberculosis.

It was distressing to observe her wasted and delicate form

human consumption. Post-mortem examination abnormal in the udder, nor were there tubercles in the intestines, except in the mesenteric lymph glands, were enlarged, and some were caseated. All were im- abundant fat.

cavity we found pleural adhesions of the lungs and gs of lungs and chest, studded with masses of millet- All the pulmonary glands were enlarged, caseated innumerable small foci of the lesions of tuberculosis. diastinal gland was nearly a foot in length. Both ly solid, filled with masses and foci of tubercles, more . In the left lung only the cephalic lobe was func- oo, contained several tuberculous foci at the edge. The osterior lobe was marbled.

lung, nearly the whole of the middle lobe was func- ested. The rest of the lung was solid tubercle. This nsumption contrasts greatly with the next.

AUTOPSY OF NO. 59.

e of the three surviving members of the old herd, ous in 1894, at the age of seven years. She has been mes, during the seven years she lived since that date, ed reaction, more frequently, when tested, than any mbers of the tuberculous herd of the hospital barn. t 28th, of enfeebled vitality, due to combined old age he stood up until within two days of her demise. She ntinually a young bull-calf, her own, born the pre- y.

as away at the time of her death, and the lungs, liver ra were kept three days, immersed in a formalin so- hey were examined, August 31st. At that date de- s rank in the interior of all the organs, and there was oration, it was difficult to form an opinion as to the f the organs at the time of death. The lungs were d with blood, and there was evidence of other lung berculosis.

re tubercles also. In the posterior apex of the right lobe) was an indurated area three inches in diameter, seous cavity, breaking up into pus. A large area of

similar nature occupied the anterior and external portion of th
lobe. No other tubercles were found. The temperature re
this cow from February to June is shown in the following
and shows that she was subject to great fluctuations in her te
ture, frequently breaking out into fever periods. At her nin
test, March 22d, she gave a reaction rise of one degree.
twentieth test, June 15th, when there had been naturally a s
fever reactions, she failed to respond to the test. It is presum
the heat of the summer, combined with her enfeebled conditi
the strain of supporting her calf, were the immediate cause of

She certainly showed a comparatively limited area inva
tubercle, not sufficient of itself to cause death; yet she ha
emaciated for many months and showed the consumptive appe

The calf was tested at the same time as the mother, but it
not to have caught the disease, and probably no tubercle germ
passed from this cow.

She offered a typical case of "slow consumption," in sha
trast to No. 18. How far the numerous injections of tub
retarded the progress of the disease cannot be judged.
require a special experiment on a large number of reacting a
in similar physical condition, separating them into two grou
to receive no injections, while the cows of the other group re
various number of injections—the experiment extended for ye
give a proper answer to a question of this kind. Such an expe
can only be carried out by special legislative action, particul
regards the expense.

REMARKS ON THE TABLES.

The first table exhibits the record of abortions, showing th
were not so frequent during the past year as previously. It
certain to what cause this decrease is due. Further considera
this subject is postponed until such time as the data we have a
lated shall be sufficiently abundant for study. The herd h
treated for a protracted time with injections of iodo-phenol. I
other herds this remedy has apparently given good evidence o
a specific cure.

Next follows a table of individual special temperature reco
different dates, and finally, a very extended series of temp
observations on the members of the hospital herd, in

ntroduced into this barn and fed the milk, to see
ɔw soon) the power to react is developed and whether
ditions with this tuberculous "hospital herd" are
ction.

ıave the evidence, it does not at present point to the
the conditions offered in this barn are infectious.
ɔrove that they would not be infectious in any other
lence is negative and is not so valuable as positive

ure record is a part of a series which we hope to work
, relative to the external influences that modify the
ınimals.

abbreviations have been used :

n.
isen.

vatered recently.

O. Cow is or has just been running out in the yard.
r. Cow arose some minutes ago.
o. Old thermometer.
n. New thermometer.

is not specified, the following routine applies to the
ering of this herd :

ıt to water (1 P. M. on Sundays).
to barn (2 P. M. on Sundays).
ı milked.

en giving extended tables of temperatures, in all cases
[V.) where the temperature exceeds 100° only the

. . .) indicate omission of observations at hours due.
indicates a longer period of rest from observing.

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lves were the offspring of members of the tuberculous herd.

TABLE III.*

Record of Abortions in College Herd, November, 1900—November, 1901.

COWS.	Stall.	Age—years.	Date of purchase.	Date of service.	Date of abortion.	Months of pregnancy.	PREVIOUS SERVICE OF BULL. Cow.	PREVIOUS SERVICE OF BULL. Date.	Vitality of calf.
No. 21	21	5	Oct. 3, 1899.	Nov. 15, 1900.	May 18, 1901.	6	Sebolt.	Nov. 15, 1900.	Alive; died.
Regena, 3d	26	3	Raised.	Feb. 27, 1901.	May 31, 1901.	3	Sebolt, 2d.	Mar. 26, 1901.	Dead.
Princess (fifth time)	30	5	Sept. 22, 1896.	Dec. 28, 1900.	June 28, 1901.	6	No. 14.	Nov. 28, 1900.	Alive; died.
No. 4.	4	8	Nov. 3, 1898.	Jan. 10, 1901.	July 15, 1901.	$6\frac{1}{8}$	B. B. Heifer.	Jan. 17, 1901.	Alive; died.
Elixir	31	12	Sept. 22, 1896.	Jan. 25, 1901.	Aug. 1. 1901.	$6\frac{1}{4}$	B. B. Cow.	Jan. 22, 1901,	Dead.

* Observed and recorded by C. B. Lane.

TABLE IV.

Special Tests.

	Lilith.	Myrtle.	Roseolas.	Guernsey Bull.	Raritan Cow.	No. 18.	96's Calf.	14's Calf.
	1st.	1st.	1st.	3d.	?	3d.	3d.	3d.
	Oct. 7, 1900.	Oct. 7, 1900.	Oct. 7, 1900.	Feb. 19, 1901.	Apr. 24, 1901.	Apr. 24, 1901.	July 15, 1901.	July 15, 1901.
	....	....	....	Nov. 5, 1900.	......	Oct. 19, 1900.	June 15, 1901.	June 15, 1901.
	Injection made at 5 P. M.							
	....	....	....	102.2	102.0	101.5	....	....
	101.7	101.6	101.7	102.0	101.2	101.8	102.8	103.0
	103.0	102.4	102.8	101.7	101.5	102.5	103.8	103.4
	102.6	102.1	102.1	101.0	101.4	101.2	103.6	103.5
	102.4	101.6	102.0	100.6	101.2	102.0	104.0	103.6
	102.2	101.4	101.9	101.6	101.8	102.2	104.0	103.5
	102.1	101.8	102.0	101.0	101.8	103.0	103.7	103.6
	101.2	101.6	100.7	101.6	101.5	106.0	103.6	102.0
	101.8	101.1	101.4	....	....	....	....	....
	101.7	101.8	102.0	....	101.8	104.6	....	....
	101.4	101.0	101.9	101.8	102.0	103.9	102.1	101.8
	101.5	101.0	101.6	101.6	101.1	104.0	102.2	101.8
	102.8	101.8	101.7	102.0	101.0	104.2	102.4	102.0
	102.8	101.6	101.6	102.0	100.8	105.0	102.8	102.0
	102.1	101.8	101.5	101.7	101.5	105.0	102.8	102.2
	101.1	101.4	101.8	101.7	100.6	105.1	102.4	102.0
	102.0	101.8	101.5	102.0	101.8	104.8	102.8	102.1
	102.0	101.4	102.0	101.5	100.9	104.0	102.8	102.4
	102.0	101.5	101.7	101.6	101.5	103.7	102.5	102.4
	102.0	101.6	101.8	101.4	100.7	100.8	102.6	102.2
	102.5	101.8	102.0	101.6	101.2	100.8	102.5	102.2
						Reacts.		

TABLE V.

Temperatures of Tuberculous Cows and Their Offsprin

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 96.	Calf of 14.
1901.						
February 22—						
11 A. M.	102.8	100.8	100.9	100.8	102.6	102.4
12 M.	2.5	0.9	0.6	1.0	2.5	2.8
1 P. M.	3.9	0.7	99.8	99.9	2.8	2.4
2 "	1.8	1 5	0.8	1.8	2.4	2.7
3 "	1.9	1.1	0.7	1.9	2.9	2.6
4 "	2.0	1.2	0.4	1.9	2.7	2.9
5 "	2.0	0.9	0.9	2.1	2.7	3.0
6 "	2.6	0.7	1.2	2.4	3.2	3.2
7 "	2.0	1.4	1.0	2.0	3.8	2.9
8 "	2.2	1.8	1.8	1.7	3.5	2.7
9 "	2.8	1.8	1.0	1.8	2.8	2.7
10 "	....	....	....	....	....	....
11 "	....	....	....	....	....	....
February 23	....	....	....	....	....	....
4 A. M.	1.8	99.8	0.8	1.0	2.8	2.2
5 "	1.7	0.5	1.0	1.2	2.6	1.6
6 "	1.2	1.2	0.6	1.0	2.8	1.6
7 "	1.2	99.2	1.5	1.7	2.2	2.1
8 "	1.2	0.7	1.6	1.6	2.6	2.2
9 "	1.1	0.9	1.2	1.9	1.9	2.2
10 "	1.0	1.6	1.4	1.8	1.9	2.1
11 "	0.9	1.2	0.6	1.8	2.0	1.8
12 M.	1.8	1.6	1.4	2.2	2.7	1.7
1 P. M.	1.0	1.5	1.4	2.0	1.7	2.3
2 "	98.6	0.4	0.7	99.4	1.9	2.8
3 "	98.8	0.5	0.8	98.5	2.1	2.2
4 "	0.5	99.4	0.7	99.2	2.2	2.9
5 "	1.1	0.9	1.8	0.5	2.8	3.9
6 "	1.8	1.1	1.0	0.6	3.2	2.5
7 "	1.2	1.0	0.7	0.8	2.2	2.4
8 "	0.8	98.6	0.8	0.2	2.6	2.8
9 "	1.0	99.7	0.7	1.0	2.6	2.8
10 "	99.8	99.6	0.0	0.4	2.7	2.1
11 "	0.7	0.8	1.2	0.8	1.6	2.5
12 Midnight	0.2	98.8	1.2	0.6	1.8	2.0
February 24—						
1 A. M.	0.5	98.8	1.2	1.8	2.8	2.6
2 "	0.0	97.8	1.0	0.0	2.0	2.7
3 "	0.8	0.0	1.0	0.2	2.6	2.2
4 "	....	....	....	....	....	....
5 "	2.6	98.1	1.2	0.9	2.4	1.7
6 "	1.8	0.4	1.2	1.1	2.2	2.1
7 "	1.6	0.8	1.4	0.8	1.7	3.3

TABLE V.—Continued.

res of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	
1.8	0.7	1.7	1.3	1.6	1.8	....
0.9	0.9	1.6	1.0	2.3	2.7	....
1.6	1.4	1.2	1.6	2.0	2.7	....
1.9	1.5	1.3	2.0	2.3	2.0	....
2.0	2.0	1.1	1.8	1.3	2.4	....
0.1	0.6	0.8	0.0	0.6	2.1	....
99.7	0.3	0.9	99.7	2.0	2.9	....
99.8	0.7	1.0	0.3	2.2	2.6	....
1.2	99.2	C.9	0.8	1.7	2.9	....
1.7	0.3	1.3	1.4	1.8	2.7	....
0.5	0.8	1.2	1.3	3.2	4.0	....
R. 98.6	R. 97.6	0.2	0.5	2.2	3.2	....
1.2	r. 99.2	0.9	0.7	2.4	3.4	....
0.9	S. 99.1	1.0	1.0	2.8	3.3	....
....	....	....	....	....	....	....
1.1	3.3	0.6	1.8	1.7	3.7	....
F. 1.4	1.1	1.1	2.1	3.0	3.5	....
R. 1.8	R. 0.8	R. 1.5	R. 1.5	2.8	3.8	....
R. 1.0	R. 3.7	R. 0.5	R. 1.4	3.4	3.7	....
1.5	R. 0.1	99.9	R. 1.8	2.5	4.5	....
2.2	99.3	0.0	1.5	2.9	4.1	....
R. 1.3	R. 0.8	R. 0.7	R. 1.5	2.4	3.9	....
1.7	R. 99.3	R. 0.2	R. 1.5	2.4	4.1	....
R. 2.0	R. 99.9	R. 0.9	R. 1.4	2.3	4.2	....
1.8	R. 99.7	R. 0.2	1.4	1.9	4.9	....
R. 1.9	R. 99.4	R. 0.1	R. 1.1	1.6	4.0	....
R. 1.4	L. 99.1	R. 99.8	R. 1.0	2.2	3.7	....
R. 1.0	R. 98.9	1.1	1.2	2.0	3.0	....
1.9	R. 98.2	0.0	1.3	2.0	3.5	....
R. 2.2	0.5	R. 0.4	1.5	2.0	3.0	....
2.5	1.0	0.5	1.8	2.0	2.5	....
1.3	R. 99.5	0.2	1.8	2.0	2.5	....
R. 2.1	1.3	0.6	1.8	2.0	2.7	....
R. 2.6	R. 0.4	R. 0.5	1.5	1.5	2.9	....
1.7	1.4	0.9	1.8	0.8	2.7	....
R. 1.3	R. 99.8	R. 1.5	2.0	1.8	2.7	....
0.8	1.5	1.7	0.7	2.0	2.3	....
0.1	1.9	1.9	1.2	2.2	2.6	....
0.9	1.7	1.4	1.1	2.8	3.2	....
0.8	R. 0.0	0.5	1.0	2.6	3.0	....
0.9	1.3	0.6	1.3	2.7	3.1	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offsprin

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
March 2—						
6 P. M.	1.7	1.1	0.7	1.4	2.4	2.8
7 "	R. 1.2	R. 99.1	R. 99.8	0.8	2.9	3.0
8 "	R. 1.9	R. 98.8	99.6	R. 0.8	2.4	2.4
9 "	R. 1.8	R. 0.1	R. 1.0	R. 0.5	2.6	2.2
10 "	1.4	R. 0.6	0.9	0.6	2.6	2.7
11 "	R. 99.4	R. 99.0	R. 0.9	0.6	2.4	2.8
12 Midnight	1.9	0.8	1.0	0.8	2.8	2.2
March 3—						
1 A. M.	1.5	0.6	1.2	0.5	2.6	2.8
2 "	1.0	R. 99.7	R. 0.8	0.4	2.5	2.8
3 "	1.0	99.7	1.0	0.9	2.0	1.7
4 "	R. 0.9	99.9	R. 1.2	0.7	2.2	2.2
5 "	1.0	0.2	R. 1.8	0.4	1.5	1.7
6 "	1.0	0.7	1.0	0.5	2.0	2.8
7 "	0.1	0.6	1.5	0.7	1.8	1.9
8 "	1.4	0.5	1.2	0.7	1.4	2.0
9 "	2.1	0.6	1.6	0.5	0.2	2.2
10 "	1.6	1.1	1.1	1.4	1.8	2.8
11 "	1.4	1.1	1.2	1.4	2.1	2.2
12 M.	1.4	1.4	1.4	1.8	2.6	2.7
1 P. M.	1.5	1.8	1.2	1.9	L. 2.0	L. 2.8
2 "	1.4	1.7	2.1	1.8	1.8	L. 2.4
3 "	1.5	1.8	1.8	1.9	L. 2.0	L. 2.2
4 "	1.1	R. 99.4	R. 1.5	0.7	2.8	3.1
5 "	1.9	0.0	1.5	0.7	2.5	2.7
6 "	R. 99.8	R. 0.8	1.2	0.8	2.6	3.0
7 "	1.0	0.1	1.1	1.0	2.2	3.0
8 "	1.6	1.8	1.1	1.6	2.6	3.0
9 "	1.2	1.0	0.5	1.0	2.6	2.9
10 "	1.4	99.9	0.6	1.4	2.6	2.8
11 "	1.6	0.5	0.6	1.4	2.6	2.7
12 Midnigat	......	......	......	......	......	......
March 4...	......	......	......	......	......	......
3 A. M.	1.6	99.6	0.6	1.4	2.8	2.8
4 "	1.7	0.1	0.8	1.0	2.1	2.0
5 "	1.7	R. 99.8	R. 0.1	2.0	1.9	1.9
6 "	1.2	0.2	R. 99.4	1.8	1.8	1.9
7 "	1.5	1.5	0.9	1.6	2.1	2.0
8 "	......	......	......	......	......	......
March 8—						
4 P. M.	n. 0.3 o. 0.8	0.7	1.1	1.5	2.6	2.8

TABLE V.—Continued.

s of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	
1.5	1.7	1.2	2.2	3.6	2.5	....
1.6	1.7	1.3	2.0	3.0	2.9	....
1.1	n. 1.5	0.3	n. 2.0	n. 2.1	n. 2.2	....
1.6	o. 1.3		o. 1.8	o. 2.3	o. 1.8	....
1.6	0.4	0.8	1.2	2.5	2.7	....
1.3	0.8	0.0	1.0	2.2	2.4	....
0.5	0.4	0.5	0.3	2.5	2.2	....
0.6	0.2	99.6	0.6	2.4	2.2	....
0.8	0.3	0.6	0.5	2.4	2.2	....
1.2	0.4	0.2	0.6	2.0	1.8	....
0.4	0.6	0.2	0.2	2.0	2.0	....
0.6	99.6	0.0	0.4	2.0	1.6	....
1.0	0.3	0.1	0.6	2.2	1.8	....
1.5	99.8	0.0	0.5	1.5	1.8	....
1.2	99.4	0.7	1.0	1.4	1.5	....
1.4	0.9	0.7	1.5	1.9	2.4	....
1.9	1.1	1.3	2.1	1.6	1.6	....
1.5	0.9	R. 0.4	1.7	1.5	2.2	....
1.3	1.5	1.0	1.6	1.5	2.0	....
2.0	0.6	R. 0.5	1.6	1.7	1.5	....
1.8	0.2	1.0	1.3	1.5	1.5	....
1.7	0.7	1.0	1.6	1.8	1.7	....
0.5	1.5	0.9	1.8	1.6	2.0	....
99.4	1.5	1.6	1.5	2.5	2.5	....
0.0	0.4	1.7	1.7	2.1	2.7	....
1.0	1.3	1.2	1.4	2.6	2.6	....
1.4	1.6	0.7	1.6	2.3	2.4	....
1.3	1.6	0.3	1.2	2.8	2.4	....
1.2	0.8	1.2	1.3	2.6	2.6	....
1.4	R. 0.1	0.0	1.0	2.5	2.6	....
1.2	R. 0.2	R. 1.1	R. 0.8	2.6	2.3	....
1.3	R. 99.4	99.4	0.4	2.3	2.2	....
0.1	0.3	0.5	0.8	2.3	1.9	....
1.3	0.5	0.7	0.4	2.4	2.1	....
1.2	R. 0.6	0.9	0.9	2.0	2.3	....
0.4	R. 0.4	1.3	0.8	2.8	2.1	....
1.2	99.6	R. 99.6	0.0	2.3	2.5	....
0.9	99.6	0.4	99.5	2.2	2.0	....
0.2	R. 99.8	1.1	0.3	2.2	1.6	....
0.8	1.2	0.8	0.7	1.8	1.8	....
1.0	0.8	0.6	1.6	2.8	2.6	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offspr

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
March 10—						
9 A. M.	0.2	1.2	1.8	1.8	1.8	2.2
10 "	1.6	1.5	0.7	1.9	1.8	2.0
11 "	1.8	1.2	1.2	1.6	2.1	1.5
12 M.	0.2	1.1	1.2	1.6	1.9	1.9
1 P. M.	1.0	1.2	0.8	1.5	2.3	2.7
2 "	1.0	0.7	1.2	1.8	2.2	2.8
3 "	W. 98.9	0.4	0.8	99.8	n. 1.9 o. 1.4	2.5
4 "	n. 99.2 o. 99.0	0.0	0.8	98.7	1.7	2.2
5 "	99.4	1.0	1.1	99.2	2.2	2.4
6 "	n. 98.6 o. 98.0	1.4	0.7	99.8	2.4	2.2
7 "	0.0	99.9	1.1	99.9	2.2	2.8
8 "	n. 0.4 o. 0.7	99.8	0.8	99.8	2.6	2.6
9 "	0.2	98.6	R. 0.9	R. 98.7	2.6	2.4
10 "	0.2	99.2	0.2	R. 98.9	2.2	2.4
11 "	0.2	R. 98.6	0.2	0.5	1.9	2.8
12 Midnight	0.6	0.0	0.0	1.3	2.5	2.8
March 11—						
1 A. M.	0.4	99.7	0.2	99.4	2.6	2.0
2 "	0.0	98.8	0.2	99.0	2.0	1.8
3 "	99.9	n. 98.3 o. 98.0	0.7	0.1	2.2	2.1
4 "	0.6	98.6	0.2	0.0	2.3	1.1
5 "	99.8	98.6	0.5	0.5	2.2	1.8
6 "	0.1	99.2	99.6	0.8	2.8	1.4
7 "	0.8	99.3	0.6	1 6	2.0	1.1
March 15—						
4 A. M.	0.4	1.4	1.0	1.0	2.2	2.1
5 "	0.5	0.8	1.1	2.0	2.6	3.0
6 "	1.2	1.0	1.5	2.0	2.8	2.8
7 "	2.4	1.7	1.1	1.6	2.2	2.6
8 "	0.4	99.5	98.7	1.0	2.0	2.0
9 "	0.8	99.6	0.5	1.2	2.1	2.3
10 "	1.1	0.5	0.0	0.7	1.9	2.8
11 "	0.3	99.6	99.7	0.5	1.7	2.0
12 Midnight	99.8	99.3	99.7	0.8	1.8	1.8
March 16—						
1 A. M.	0.9	98.2	99.5	0.8	2.0	2.2
2 "	0.7	99.7	0.2	1.3	2.0	2.1
3 "	1.0	0.2	0.7	1.4	2.0	2.2
4 "	1.2	98.3	0.2	1.2	2.0	2.3

TABLE V.—Continued.

res of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	
0.7	99.1	98.8	1.6	1.8	1.6	....
0.2	99.8	0.4	1.4	1.9	1.7	....
99.8	0.6	0.4	1.6	1.7	1.7	....
0.5	0.1	0.7	1.5	1.7	1.7	....
1.8	0.6	99.9	1.4	2.8	2.8	....
1.4	R. 0.6	1.0	1.7	2.1	2.2	....
1.3	1.2	1.1	1.5	2.0	2.1	....
1.4	1.0	1.8	1.8	1.2	1.5	....
1.6	1.2	1.1	1.6	2.2	1.8	....
0.2	0.5	0.7	1.8	1.5	2.1	....
99.6	1.0	99.6	1.8	2.1	2.8	....
0.8	1.2	0.6	1.1	2.8	2.8	....
1.9	0.4	1.1	1.0	3.1	2.6	....
1.8	1.8	1.3	1.8	2.1	2.4	....
1.0	1.0	0.7	1.8	1.2	2.6	....
1.2	99.9	99.9	1.8	1.8	2.1	....
1.0	99.8	0.0	0.6	2.0	1.9	....
0.8	0.2	0.7	R. 0.7	2.8	1.9	....
R. 0.9	R. 0.0	0.4	R. 0.5	1.6	2.8	....
99.1	98.0	99.4	99.7	2.1	1.4	....
0.5	98.4	0.6	99.8	1.7	1.8	....
0.8	99.4	0.8	1.0	2.0	1.6	....
1.2	0.5	0.8	0.7	2.2	1.5	....
99.7	98.7	0.7	99.6	1.9	1.6	....
0.2	98.9	0.8	0.0	2.0	1.2	....
0.1	98.0	0.5	0.6	1.6	1.1	....
0.0	99.2	0.7	0.9	1.9	1.4	....
0.9	0.4	1.0	1.2	1.9	1.9	....
1.1	99.2	0.9	1.0	1.8	1.8	....
1.8	0.2	1.0	1.0	1.8	2.7	....
1.8	1.5	1.4	1.7	1.7	1.6	....
1.8	1.2	1.2	2.0	2.2	1.9	....
1.9	2.0	1.6	2.1	2.4	2.8	....
1.7	1.8	1.2	1.2	1.2	2.0	....
0.6	R. 0.6	R. 99.8	R. 0.5	2.0	2.0	....
99.8	1.0	0.9	0.7	2.0	2.2	....
0.5	0.2	0.4	1 2	2.5	8.1	....
1.8	0.8	0.5	1.1	2.4	2.8	....
1.1	1.1	0.5	0.8	2.5	2.8	....
0.4	R. 99.8	0.6	0.6	1.8	2.2	....
0.7	99.8	0.8	1.0	2.2	2.2	....
0.2	1.0	1.0	0.8	1.6	2.0	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offspr

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 35.	Calf of 14.
1901.						
March 17—						
11 P. M.	99.7	1.0	0.8	0.9	1.6	2.
12 Midnight	....	....	....	....	....	....
Minims inje'd at 6 P. M.	80	90	75	60	7	14
March 22—						
4 P. M.	1.8	1.0	1.4	1.5	1.8	2.
5 "	1.0	1.1	1.5	1.8	2.0	2.
6 " (Injected)	1.6	1.2	1.7	1.8	2.6	2.
7 "	1.2	1.2	1.8	1.6	3.3	3.
8 "	0.7	0.2	1.5	1.0	2.5	2.
9 "	0.4	0.5	1.3	0.6	2.8	2.
10 "	0.4	0.8	1.2	1.2	2.4	2.
11 "	0.8	0.6	0.7	1.7	1.8	1.
12 Midnight	0.3	1.0	2.4	1.1	2.4	2.
March 23—						
1 A. M.	R. 1.0	R. 1.0	R. 2.3	0.1	2.0	1.
2 "	0.7	1.0	2.4	1.0	2.6	1.
3 "	....	....	....	....	....	....
4 "	0.7	0.3	3.0	0.4	1.5	2.
5 "	0.8	1.4	3.4	0.7	1.8	0.
6 "	1.3	1.2	3.6	0.2	1.9	1.
7 "	1.0	1.0	3.1	99.9	O. 0.4	1.
8 "	1.6	1.7	3.0	0.7	2.0	2.
9 "	1.8	1.9	2.9	1.4	2.3	2.
10 "	1.6	2.8	3.6	1.8	2.0	2.
11 "	1.4	3.0	2.8	2.9	2.0	2.
12 M.	2.6	2.8	3.3	2.5	2.2	1.
1 P. M.	2.4	2.6	3.6	3.0	2.2	1.
2 "	1.7	2.7	2.9	3.0	2.2	1.
3 "	2.4	2.4	2.6	3.2	1.9	1.
4 "	3.1	1.5	1.2	3.6	2.5	1.
5 "	2.5	1.4	1.7	4.0	2.8	1.
6 "	1.9	1.1	1.8	4.0	2.0	2.
7 "	2.2	1.0	1.2	3.9	2.5	3.
8 "	1.7	0.4	0.2	3.5	2.7	2.
9 "	1.9	99.8	0.9	3.6	3.3	2.
10 "	L. 0.2	L. 0.0	0.2	3.0	2.6	2.
11 "	L. 0.2	99.5	0.3	2.2	2.8	2.
12 Midnight	S. 99.5	98.2	0.0	1.8	1.8	1.
March 24—						
1 A. M.	0.2	99.3	0.7	1.3	1.7	1.
2 "	0.8	98.5	99.6	1.0	1.7	1.
3 "	0.0	98.6	99.8	0.4	1.7	0.
4 "	0.5	98.7	0.3	0.7	2.1	0.

TABLE V.—Continued.

es of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	Extra Calf.
0.5	98.5	99.5	0.8	1.5	0.6	1.6
0.8	0.4	99.9	1.8	2.0	1.0	1.5
1.0	99.2	0.0	0.9	2.0	0.7	....
0.8	0.8	99.6	0.9	1.7	0.9	2.0
1.2	0.5	99.5	1.0	2.0	2.1	1.4
1.6	0.7	99.8	1.8	1.6	1.2	2.1
2.1	1.0	1.0	1.9	1.7	1.2	1.8
1.5	0.1	0.7	1.5	1.5	1.9	....
1.7	0.9	1.2	0.0	1.2	1.5	1.8
0.0	0.8	1.8	0.2	1.2	1.6	....
1.1	99.8	1.2	99.6	1.6	1.8	2.4
1.6	0.8	1.8	0.8	1.8	1.8	2.2
1.2	R. 99.5	R. 1.0	R. 0.4	2.0	1.7	2.2
1.0	0.0	1.0	0.8	1.9	1.7	2.4
1.5	0.4	1.2	1.8	2.2	2.2	2.6
1.7	99.8	0.1	1.2	2.7	2.2	2.5
1.4	0.0	0.4	0.6	2.2	2.2	....
1.8	99.6	0.7	99.8	2.2	2.8	2.6
0.8	0.8	1.0	0.0	2.3	1.9	....
1.2	R. 98.8	0.2	0.6	1.2	1.5	2.4
1.0	98.4	0.8	0.8	1.9	1.8	2.8
0.5	0.2	99.0	99.4	2.2	1.9	2.0
0.4	98.6	0.0	0.8	2.0	1.7	....
....	....	....	....	....	....	....
0.3	98.1	0.4	0.2	1.7	1.2	2.0
0.5	99.4	0.8	0.4	1.6	1.6	1.8
0.8	0.7	0.5	0.1	2.0	1.4	2.7
0.2	0.8	99.6	0.7	2.2	1.4	....
0.7	0.8	1.1	1.6	2.0	1.8	1.9
1.4	0.8	1.2	2.0	3.8	1.8	2.6
1.8	0.7	1.8	1.4	O. 2.8	2.0	2.2
1.0	0.7	1.1	1.8	2.5	2.6	2.1
99.9	99.8	0.8	1.4	2.0	2.5	2.4
99.5	99.7	99.9	0.8	2.2	1.8	2.1
0.7	0.0	1.2	0.6	2.1	1.9	2.0
1.0	0.5	2.0	0.8	1.9	1.6	2.0
0.4	99.8	0.9	0.8	1.9	1.9	1.8
0.5	99.7	0.0	0.8	1.8	1.5	2.1
....	....	....	....	....	....	....
0.2	97.8	1.2	0.2	1.4	1.4	2.0

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offsp

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
March 30—						
3 A. M.	....	....	....	....	....	....
4 "	0.4	98.4	99.3	99.8	1.8	1.
5 "	0.7	99.0	0.8	0.8	1.7	0.
6 "	0.0	99.8	0.8	0.2	1.4	0
7 "	0.2	99.8	0.8	1.2	1.0	1
8 "	0.2	0.2	1.0	1.6	1.6	0
9 "	0.4	0.8	99.8	1.8	1.4	1
10 "	1.0	0.8	1.0	1.6	1.1	0
11 "	1.6	1.0	1.0	1.7	1.2	1
12 M.	0.0	0.9	0.5	1.2	1.0	0
1 P. M.	1.2	0.6	0.7	1.6	1.5	0
2 "	1.2	0.8	0.6	2.0	1.6	2
3 "	0.7	0.9	1.4	1.6	1.5	1
4 "	1.4	0.7	1.8	1.1	1.8	2
5 "	1.0	0.5	0.8	0.8	1.9	1
6 "	1.8	0.7	0.7	1.3	2.4	2
7 "	1.9	99.0	0.7	0.4	2.8	2
8 "	0.8	0.2	1.2	1.0	2.8	2
9 "	0.7	99.6	0.7	99.9	2.0	1
10 "	0.1	99.8	0.7	0.4	1.6	1
11 "	1.0	98.2	1.0	0.5	1.8	2
12 Midnight	0.2	99.2	0.6	0.2	2.8	1
March 31—						
1 A. M.	1.4	98.8	0.8	99.8	1.2	1.
2 "	1.0	98.2	0.6	0.0	1.7	1
3 "	0.8	99.0	0.5	0.0	1.6	1
4 "	0.6	98.8	0.5	99.5	1.4	1
5 "	0.8	97.8	0.6	99.8	1.8	0
6 "	98.6	98.8	0.4	0.0	1.4	1.
7 "	1.8	98.8	0.0	0.7	1.5	1
8 "	99.9	99.2	0.6	0.4	1.7	2
9 "	0.8	99.5	0.6	1.3	1.5	1
10 "	1.8	0.6	1.0	1.6	1.6	1.
11 "	0.4	0.6	1.0	1.6	1.6	1.
12 M.	1.5	0.5	1.0	1.8	1.4	1.
1 P. M.	0.2	0.6	1 2	1.4	1.4	1.
2 "	1.6	1.8	0.7	1.8	1.6	1.
3 "	1.5	0.6	0.2	0.7	1.7	1.
4 "	1.8	0.5	0.2	0.7	2.1	1.
5 "	1.0	0.1	0.7	0.8	2.8	1.
6 "	2.0	0.6	0.6	1.2	2.4	2.
7 "	1.5	0.7	0.7	0.5	2.5	1.

TABLE V.—Continued.

res of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	Extra Calf.
1.3	0.2	0.6	0.4	2.7	2.5	2.3
0.8	0.4	0.3	0.7	2.6	2.4	2.3
1.0	0.4	0.7	0.2	2.1	2.3	2.0
0.0	96.8	0.1	99.7	2.6	1.8	....
99.7	98.9	0.4	99.8	2.4	1.6	1.7
....	....	....	....	....	....	....
1.4	98.4	0.6	99.0	2.8	1.6	1.6
0.6	98.6	0.8	99.9	2.1	1.4	1.6
1.8	99.4	0.8	0.8	2.1	1.2	1.6
0.0	99.6	0.7	99.8	1.6	1.0	0.2
0.6	99.6	9.5	99.8	1.5	0.8	1.1
0.4	0.2	1.0	0.9	1.4	0.5	....
2.0	0.7	0.8	0.6	0.6	0.6	1 5
1.5	1.4	0.9	1.4	1.7	0.5	1.8
2.8	1.5	0.9	1.4	1.2	1.2	1.5
1.9	1.7	0.7	1.6	1.8	2.0	2.0
2.1	1.8	0.9	1.8	1.8	1.6	1.9
8.0	0.8	0.4	1.8	1.8	1.4	....
2.2	0.8	1.8	1.4	1.6	1.5	1.8
1.7	1.5	1.4	1.6	2.1	1.7	1.9
1.2	0.7	1.2	1.0	2.8	1.4	1.9
2.7	1.1	1.2	1.6	2.7	2.6	2.6
2.1	1.2	1.2	1.8	3.0	1.8	....
2.2	1.4	1.4	1.8	2.2	2.2	2.1
4.0	0.7	1.4	1.0	2.0	1.9	2.2
4.5	99.0	1.0	0.7	1.8	1.9	2.1
4.6	0.6	0.8	0.8	1.9	2.0	2.2
4.0	0.6	0.6	0.8	2.0	2.0	....
2.4	98.9	0.5	99.8	1.6	1.5	1.9
3.4	99.8	0.9	99.7	1.7	1.6	1.9
2.5	99.4	0.5	99.4	2.0	1.5	1.6
2.0	99.9	0.6	99.4	1.8	1.3	1.7
....	....	....	....	....	....	....
2.0	98.3	0.4	0.0	1.6	0.7	1.2
0.8	99.1	99.7	99.7	1.2	1.0	2.0
1.8	0.1	0.6	0.6	1.8	1.4	1.4
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
2.4	97.9	0.7	1.0	1.3	1.8	2.1

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offsprin

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
April 7—						
4 A. M.	2.1	0.6	0.4	1.8	0.8	1.2
5 "	1.4	0.8	0.8	1.2	1.1	1.1
6 "	8.2	0.0	1.0	0.9	0.9	1.2
7 "	8.8	99.8	1.0	0.8	0.9	1.1
8 "	2.9	0.8	0.2	0.4	1.7	0.5
9 "	8.7	1.0	1.8	1.5	1.8	1.8
10 "	W. 99.8	W. 99.8	W. 0.6	W. 97.8	0.8	2.8
11 "	98.5	0.6	0.2	97.8	1.2	1.8
12 M.	98.6	99.6	0.6	97.6	1.2	1.5
1 P. M.	99.7	0.2	0.2	97.0	1.0	1.7
2 "	0.4	99.8	0.5	98.8	0.9	1.5
3 "	0.6	0.0	1.2	98.6	1.6	1.4
4 "	1.6	99.4	1.0	99.8	1.8	1.6
5 "	2.0	0.0	0.4	0.1	1.9	1.9
6 "	8.7	1.0	0.6	1.8	2.8	2.4
7 "	4.0	0.9	0.5	1.4	1.9	1.4
8 "	2.5	0.5	1.0	0.6	1.6	2.8
9 "	8.6	99.6	0.9	1.0	1.5	1.5
10 "	8.7	99.4	1.7	1.0	1.9	1.4
11 "	8.6	99.8	1.0	1.0	1.8	1.8
12 Midnight	2.5	0.0	1.0	0.5	1.4	1.5
April 8—						
1 A. M.	....	....	....	....	....	....
2 "	1.8	99.8	0.5	99.9	1.0	1.0
3 "	1.5	99.2	1.0	99.8	0.9	1.0
4 "	1.6	0.0	0.9	0.0	1.0	0.6
5 "	2.0	0.0	0.7	0.6	0.5	0.6
6 "	2.7	99.6	0.7	0.9	0.7	0.8
7 "	2.5	0.7	0.9	0.6	1.4	0.6
8 "	2.5	1.0	0.5	0.7	0.9	0.9
9 "	2.5	1.5	1.4	1.2	1.2	2.8
10 "	8.8	1.2	....	....	....	....
11 "	n. 8.7	n. 2.6	n. 1.6	n. 2.1	n. 1.5	n. 1.6
12 M	4.0	2.8	1.6	2.8	1.5	1.6
1 P. M.	8.5	1.8	1.3	2.5	1.4	1.4
2 "	8.8	2.9	2.4	1.4	1.5	1.4
3 "	W. 1.7	W. 2.6	W. 0.5	0.0	1.7	1.7
4 "	1.2	2.6	0.6	99.8	1.8	2.2
5 "	1.8	2.2	0.6	99.5	2.2	2.0
6 "	1.8	8.0	1.0	1.8	2.5	2.0
7 "	2.6	8.0	1.0	1.4	2.5	2.0
8 "	....	....	....	....	....	....
9 "	n. 8.8	n. 1.8	n. 1.2	n. 1.2	n. 1.8	n. 1.5

TABLE V.—Continued.

...ures of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	Extra Calf.
8.0	1.0	0.8	0.8	1.8	1.8	2.0
8.0	2.0	1.0	1.0	1.5	1.4	2.0
....	....	....	....	....	....	....
8.2	0.2	1.0	0.6	0.8	1.4	1.4
8.0	0.4	0.8	0.4	0.8	1.0	1.7
....	....	....	....	....	....	....
2.0	0.5	0.5	0.8	0.9	0.0	1.4
2.0	0.4	99.9	0.4	0.6	0.2	....
2.2	99.0	0.4	99.5	0.4	0.8	1.0
8.0	0.8	0.8	0.8	0.6	0.2	....
2.4	0.8	0.7	0.5	0.8	0.4	1.0
2.8	0.8	0.8	1.7	1.8	1.0	1.7
2.0	1.0	1.4	2.5	1.4	0.8	1.4
2.8	0.6	1.0	2.6	1.8	1.2	1.6
2.8	1.0	1.4	2.4	1.4	1.4	1.8
8.4	99.8	1.0	2.0	1.2	1.0	1.4
8.9	0.6	1.4	2.4	1.6	1.4	1.8
2.9	0.0	0.8	0.1	1.9	1.7	2.1
2.8	99.0	0.7	0.2	2.0	2.0	....
2.5	0.2	0.5	0.2	2.6	2.5	2.7
2.4	0.0	0.5	1.0	2.6	2.4	2.6
8.6	0.2	0.9	1.6	2.4	1.9	2.5
8.8	0.6	0.6	0.5	2.2	2.0	2.4
8.0	99.0	1.0	0.8	2.2	1.9	....
....	....	....	....	....	....	....
2.0	99.0	0.9	0.5	1.9	1.4	1 4
8.8	99.2	0.8	0.5	1.5	1.8	1.6
8.7	99.6	1.4	0.5	1.8	1.8	1.8
8.0	99.7	1.9	0.6	1.8	0.8	....
8.2	98.6	1.0	0.6	1.4	1.0	1.7
2.2	99.7	1.2	0.5	1.0	0.9	1.2
3.0	99.6	0.6	0.8	1.2	0.5	....
8.6	99.4	0.7	0.8	1.0	0.8	0.4
8.8	98.9	1.0	1.6	1.0	0.6	1.0
8.4	99.7	0.6	0.6	1.8	0.8	1.2
....	....	....	....	....	....	....
99.0	0.9	99.7	1.9	0.9	1.9	....
99.9	99.9	99.5	99.4	1.0	1.2	2.0
0.6	0.8	0.5	99.5	1.5	1.4	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Of

DATE.	No. 59.	No. 72.	No. 15.	No. 11.	Calf of 95.
1901.					
April 13—					
3 A. M.	99.4	99.3	99.3	0.2	0.9
4 "	0.6	0.2	0.8	99.4	0.8
5 "	.....	.....	.....	.....	.....
6 "	99.8	98.8	99.5	0.5	0.9
7 "	0.0	99.6	0.2	0.0	1.0
8 "	0.7	0.1	0.0	0.8	1.6
9 "	0.9	0.0	0.8	0.0	1.5
10 "	1.2	0.4	0.6	0.2	1.1
11 "	1.3	0.4	0.5	1.9	1.8
12 M.	1.6	1.0	0.8	1.9	1.6
1 P. M.	1.6	1.5	0.6	2.2	1.5
2 "	1.7	1.8	1.2	1.9	1.6
3 "	1.5	0.9	1.0	2.0	1.7
4 "	2.0	2.0	1.2	1.7	1.2
5 "	2.0	2.2	1.0	2.0	2.0
6 "	2.0	2.6	1.3	1.5	1.4
7 "	1.8	1.9	1.4	1.6	2.4
8 "	2.2	R. 2.2	2.2	1.0	2.7
9 "	1.1	R. 0.5	0.6	0.2	2.6
10 "	.....	.....	.....	.....	.....
11 "	.....	.....	.....	.....	.....
12 Midnight	1.7	1.0	0.7	0.0	0.9
April 14—					
1 A. M.	.....	.....	.....	.....	.....
2 "	0.4	99.7	0.4	99.7	1.5
3 "	0.8	0.0	99.7	0.8	1.6
4 "	0.1	0.0	99.9	99.8	1.5
5 "	1.1	0.0	0.8	0.2	1.3
6 "	99.8	1.6	0.0	0.0	1.3
7 "	0.7	1.0	0.3	99.7	1.2
8 "	0.7	1.8	0.0	0.4	1.8
9 "	1.0	1.7	0.0	99.8	1.8
10 "	1.6	1.5	0.3	99.2	1.2
11 "	0.0	0.8	0.0	99.1	1.1
12 M.	99.8	0.5	0.5	99.9	1.5
1 P. M.	99.8	0.9	0.4	0.1	1.5
2 "	99.4	1.2	99.4	0.6	1.8
3 "	0.4	1.2	0.6	0.2	1.9
4 "	99.6	0.5	0.4	0.2	2.2
5 "	0.2	1.3	0.3	1.0	2.4
6 "	1.3	1.6	0.2	1.8	2.6
7 "	2.2	2.1	1.2	1.5	2.6
8 "	2.0	0.3	1.5	0.7	2.4

TABLE V.—Continued.

...tures of Tuberculous Cows and Their Offspring.

	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	Extra Calf.
......	....	....	....	....	....	....	....
......	1.4	1.6	1.0	0.2	2.2	2.8	2.1
......	....	....	....	....	....	....	....
......	....	....	....	....	....	....	....
......	0.8	2.0	99.6	99.9	1.6	2.8	2.8
......	....	....	....	....	....	....	....
......	0.6	2.4	1.0	99.8	1.6	1.7	2.0
......	0.4	1.7	1.0	99.8	1.0	1.6	....
......	0.2	1.9	1.8	99.9	0.6	1.6	2.0
......	R. 0.4	R. 1.5	1.0	99.8	1.7	1.1	....
......	....	....	....	....	....	....	....
	Rainy.	Stalls	damp.				Eye hurt.
......	0.5	99.6	99.5	1.0	1.9	2.2	4.0
......	0.7	99.8	1.8	1.1	1.7	3.1	4.6
......	99.8	99.6	1.0	0.6	....	2.7	....
......	2.2	99.7	0.6	0.8	2.4	2.4	4.7
......	2.2	99.5	1.8	1.8	2.8	2.5	....
......	2.0	0.5	1.0	1.8	2.6	2.7	5.0
......	2.1	1.2	1.6	1.1	2.4	2.8	....
......	....	....	....	....	....	....	....
......	1.5	0.5	1.0	0.8	2.2	2.5	4.8
......	....	....	....	....	....	....	....
......	2.1	99.6	0.9	98.6	1.8	2.4	4.2
......	1.5	0.7	0.7	0.2	2.4	2.0	4.8
......	....	....	....	....	....	....	....
......	0.7	0.8	0.6	0.5	1.6	2.0	4.0
......	1.4	99.9	0.8	99.8	1.1	2.4	....
......	1.0	0.8	99.8	0.4	1.4	1.4	3.2
......	1.9	0.6	0.5	0.0	0.5	1.4	3.6
......	1.5	0.6	0.4	0.9	1.9	0.4	3.8
......	1.6	1.0	1.0	0.9	2.0	1.8	....
......	1.6	1.0	0.5	0.8	1.8	1.4	3.7
......	2.4	1.0	1.5	1.8	1.9	1.7	....
......	2.4	0.2	1.4	1.2	1.6	1.8	3.2
......	1.7	1.1	1.0	1.8	2.2	2.2	4.5
......	2.1	99.5	1.1	1.8	2.2	2.2	4.8
......	1.4	0.7	1.5	1.8	2.1	2.0	4.5
......	0.1	0.7	0.9	0.6	2.2	2.1	4.0
......	0.8	0.1	1.6	0.9	1.7	2.6	4.8
......	1.0	0.8	1.7	1.4	2.0	2.6	3.9
......	99.8	0.5	1.6	1.5	2.6	2.1	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offspring.

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	
1901.							
April 21—							
7 P. M.	1.3	0.9	0.5	0.2	2.6	2.8	
8 "	0.0	0.6	1.6	0.7	2.1	2.0	
9 "	1.4	0.6	0.8	0.9	2.7	1.7	
10 "	....	....	....	....	....	....	....
11 "	2.0	99.7	0.5	0.2	2.0	1.8	
12 Midnight	1.0	0.4	1.0	0.9	2.0	1.7	....
April 22—							
1 A. M.	0.9	0.4	1.0	0.9	2.3	1.5	
2 "	....	....	....	....	....	....	....
3 "	1.7	99.7	0.9	99.9	2.3	1.4	
4 "	1.2	0.4	1.0	0.2	1.4	1.2	
5 "	1.6	0.1	0.6	99.7	1.3	1.0	
6 "	0.9	0.1	1.0	0.1	1.2	1.1	
7 "	1.8	0.3	0.8	0.4	1.7	0.8	
8 "	....	....	....	....	....	....	....
April 27—							
2 P. M.	1.1	0.4	1.5	1.3	1.5	2.3	....
3 "	1.5	0.6	0.5	1.6	1.6	2.4	....
4 "	1.6	99.9	0.9	1.6	1.8	2.4	....
5 "	1.2	0.6	1.0	1.5	1.8	2.5	....
6 "	1.7	0.7	0.9	1.8	2.4	2.6	....
7 "	2.0	1.0	1.0	1.1	2.3	2.7	....
8 "	1.6	0.6	1.8	1.2	2.2	2.5	....
9 "	1.2	0.3	1.2	1.0	1.7	2.5	....
10 "	1.0	0.4	1.0	1.3	0.7	1.0	....
11 "	n. 1.2	n. 0.4	n. 0.9	n. 0.7	2.1	2.2	....
12 Midnight	2.3	0.4	1.1	0.5	2.0	2.0	....
April 28—							
1 A. M.	0.2	99.7	0.7	0.3	2.0	2.0	....
2 "	1.0	0.8	0.7	0.4	1.4	2.6	....
3 "	0.9	99.9	1.0	99.8	1.3	1.4	....
4 "	0.5	99.9	0.6	0.4	1.3	1.3	....
5 "	1.2	0.3	0.4	99.9	1.3	1.4	....
6 "	99.5	99.6	1.1	0.2	0.5	1.1	....
7 "	99.5	99.5	0.0	0.5	1.2	1.0	....
8 "	1.2	99.5	0.0	0.6	2.8	1.3	....
9 "	2.0	0.5	0.8	1.2	1.8	1.2	....
10 "	1.6	0.1	0.5	1.6	1.6	1.4	....
11 "	2.6	0.7	0.7	1.5	1.3	1.4	....
12 M.	2.2	0.6	1.2	1.6	1.2	1.9	....
1 P. M.	2.0	0.7	0.7	1.0	1.4	2.4	....
2 "	0.7	0.9	0.7	0.8	1.7	1.9	....
3 "	0.2	1.6	0.6	0.8	2.0	2.1	....

TABLE V.—Continued.

tures of Tuberculous Cows and Their Offspring.

	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	Extra Calf.
......	0.2	1.8	0.8	0.7	1.9	2.4	....
......	1.5	1.4	0.8	1.1	2.0	2.4	....
......	2.0	1.9	1.8	1.6	2.8	2.5	....
......	2.1	2.0	1.0	1.4	2.5	2.5	....
......	1.1	1.7	1.6	1.8	2.0	2.5	....
......	1.4	1.8	1.1	0.6	1.9	2.2	....
......	1.0	2.0	1.8	0.7	1.9	2.2	....
......	0.6	0.6	1.4	0.0	2.0	2.0	....
......	1.0	0.8	1.2	0.2	2.0	1.4	....
......	0.2	0.0	1.0	99.4	1.5	1.4	....
......	1.2	0.7	1.2	99.8	1.6	1.4	....
......	0.2	0.6	1.2	99.7	1.7	2.2	....
......	1.2	0.8	0.8	99.8	2.1	1.0	....
......	0.8	0.8	0.5	99.8	1.6	0.9	....
......	0.8	99.4	0.7	0.0	1.5	0.8	....
......	0.7	0.1	0.6	99.7	1.5	1.0	....
......	....	....	....	....	....	....	....
							No. 18.
......	0.5	99.2	0.8	0.4	0.0	0.5	98.8
......	0.2	0.1	0.6	99.8	1.8	1.5	0.7
......	99.8	99.8	99.7	0.2	1.9	1.4	0.8
......	0.8	0.5	99.5	99.9	1.0	1.5	0.5
......	0.7	0.7	1.0	0.2	1.4	1.4	0.8
......	1.5	1.0	0.8	1.0	1.9	1.9	1.7
......	2.0	1.2	1.0	1.4	1.7	2.0	2.2
......	2.2	1.2	1.5	1.4	1.6	1.8	1.7
......	1.8	1.8	0.8	1.5	1.6	1.8	1.8
......	1.4	1.4	1.2	2.2	1.8	2.2	1.9
......	1.4	1.1	0.9	1.6	1.5	2.2	2.5
......	1.8	0.5	1.0	1.6	1.6	1.7	2.7
......	1.8	0.9	0.8	1.1	1.6	2.0	2.9
......	1.9	1.9	1.8	1.9	2.2	2.8	2.9
......	1.0	1.2	1.8	1.6	1.7	2.5	2.7
......	1.2	1.0	1.0	1.7	1.6	2.7	2.4
......	0.8	1.7	1.7	1.7	2.2	2.4	2.4
......	....	....	....	....	....	....	....
......	1.4	0.8	1.1	99.7	1.2	2.2	1.7
......	....	....	....	....	....	....	....
......	1.2	99.7	1.0	99.7	1.0	1.8	0.8
......	99.6	0.8	0.9	99.8	1.5	1.6	0.6
......	0.0	1.2	1.2	99.0	0.6	1.8	0.9

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offsprin

DATE.	No. 89.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
May 6—						
3 A. M.	99.6	99.7	0.2	99.0	1.4	1.4
4 "	98.6	99.9	0.2	98.2	0.8	1.8
5 "	99.6	0.8	0.7	98.6	1.0	1.1
6 "	98.4	1.0	0.0	98.7	1.4	1.4
7 "	0.4	0.9	0.0	99.8	....	....
8 "	....	....	....	....	....	....
May 11—						
6 P. M.	1.6	1.8	0.4	1.4	2.0	2.2
7 "	1.4	1.6	0.8	1.0	2.2	2.4
8 "	0.9	1.1	0.6	0.6	2.2	2.5
9 "	1.5	1.2	1.0	1.2	2.2	2.6
10 "	0.9	0.7	0.9	0.4	2.0	2.2
11 "	....	....	....	....	....	....
12 Midnight	1.0	99.8	0.6	99.8	2.0	1.1
May 12—						
1 A. M.	1.6	0.4	0.6	0.2	1.6	2.0
2 "	0.8	0.7	0.2	0.8	1.1	1.7
3 "	0.8	99.2	0.2	99.9	1.2	1.6
4 "	0.6	99.4	0.1	99.9	1.2	1.4
5 "	0.2	99.0	0.2	99.8	0.7	1.6
6 "	0.6	0.1	0.1	99.9	1.5	1.2
7 "	0.8	0.0	0.8	0.2	1.4	1.2
8 "	0.2	99.6	0.4	0.2	1.2	1.5
9 "	1.8	0.0	0.6	0.8	1.6	1.6
10 "	W. 1.4	W. 1.4	W. 1.1	W. 1.2	W. 1.4	W. 1.8
11 "	....	....	....	....	....	....
12 M.	1.1	1.1	0.7	0.8	1.0	1.5
1 P. M.	1.8	1.2	0.8	1.1	1.6	1.4
2 "	1.5	1.0	1.1	1.1	1.6	1.6
3 "	1.7	1.2	1.2	1.8	1.9	1.6
4 "	2.1	1.2	1.8	1.2	1.9	2.0
5 "	2.1	1.6	1.2	1.7	1.8	2.0
6 "	2.8	2.0	1.7	1.8	2.2	2.2
7 "	2.2	1.7	1.8	1.6	1.9	2.2
8 "	3.1	1.4	0.9	1.0	2.0	2.2
9 "	1.7	0.9	1.4	0.5	2.4	2.8
10 "	1.2	0.6	1.4	0.5	1.7	2.2
11 "	0.2	0.7	0.8	0.0	1.8	1.9
12 Midnight	....	....	....	....	....	....
May 13—						
1 A. M.	0.6	0.6	0.7	99.2	0.7	1.8
2 "	....	....	....	....	....	....
3 "	1.0	99.4	0.6	0.0	1.0	1.7

TABLE V.—Continued.

ures of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.	No. 18.
96.8	98.2	0.4	98.6	0.7	1.8	2.6
0.2	99.2	0.8	98.8	0.8	1.6	1.9
0.8	98.8	0.2	99.4	0.6	1.5	0.6
1.2	99.8	99.5	99.5	1.6	1.6	0.8
....	....	....	....	....	....	....
2.2	1.2	1.2	2.1	....	....	2.6
2.5	1.2	0.8	2.2	2.4	8.0	2.4
2.1	1.1	1.2	1.7	8.0	2.4	2.6
1.8	0.9	0.4	1.2	2.5	2.6	2.4
1.5	0.7	0.7	1.8	2.5	2.2	2.0
1.0	0.6	0.4	0.8	2.2	2.2	2.0
0.4	....	....	....	....	....	1.8
....	99.0	0.2	99.8	1.7	1.7	1.7
0.5	99.9	0.6	0.0	1.8	1.2	....
0.0	0.1	99.9	0.6	1.4	0.9	1.8
0.5	99 6	99.8	0.8	1.5	1.2	1.0
0.2	99.7	0.5	0.8	1.4	1.0	0.6
0.9	0.6	0.9	0.5	1.6	1.5	0.4
1.0	0.8	1.1	1.8	1.7	1.4	0.9
2.0	1.0	1.5	1.2	1.7	1.7	1.5
1.4	1.2	1.5	1.6	2.1	1.5	1.0
1.0	1.1	1.8	1.8	1.9	1.4	1.2
1.7	0.7	1.2	0.8	1.1	1.5	1.8
1.2	0.8	0.6	1.2	1.7	1.8	1.8
2.1	1.0	1.1	1.8	1.5	1.7	2.4
2.0	0.9	0.0	1.5	1.8	1.7	2.7
1.2	1.4	1.8	1.7	1.8	1.8	8.1
1.8	1.6	0.9	1.8	1.7	1.8	8.1
2.0	1.8	1.8	1.7	2.0	1.8	4.8
1.4	1.4	1.8	1.2	2.0	2.1	4.8
1.4	1.8	0.9	1.8	1.7	1.8	4.4
....	....	....	....	....	....	....
1.8	0.0	0.6	99.9	1.6	1.5	4.1
....	....	....	....	....	....	....
1.0	0.8	0.6	0.2	1.6	1.5	4.5
....	....	....	....	....	....	....
0.6	0.0	0.8	99.7	1.4	1.1	4.8
0.8	0.8	0.8	0.7	1.6	1.2	8.5
99.7	0.4	0.9	0.1	1.4	1.0	8.0
1.7	0.5	0.0	0.2	1.2	1.4	2.2

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offspri

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
May 26—						
7 A. M.	1.8	0.0	0.5	0.8	1.5	1.4
8 "	2.0	0.5	0.6	0.8	1.4	1.8
9 "	2.0	0.8	1.1	1.1	1.5	1.7
10 "	2.8	0.8	1.1	1.5	1.5	1.7
11 "	2.0	0.8	0.4	2.0	2.0	2.0
12 M.	2.1	0.8	1.6	1.8	1.2	2.0
1 P. M.	2.0	0.8	0.3	1.1	1.7	1.6
2 "	1.8	0.8	0.8	1.6	1.6	1.6
8 "	W. 98.8	W. 0.1	W. 0.8	W. 98.8	2.0	2.1
4 "	97.4	0.5	0.1	97.8	2.0	2.0
5 "	98.2	0.1	0.2	97.7	1.7	2.6
6 "	99.9	99.9	1.1	99.2	2.1	2.5
7 "	0.1	0.8	0.8	99.8	2.4	2.4
8 "	99.7	0.0	1.0	0.1	2.4	2.1
9 "	99.9	0.1	1.1	0.2	2.8	2.4
10 "	0.8	0.0	0.7	0.2	2.5	2.4
11 "	......	......	......	......	......	......
12 Midnight	0.8	98.4	0.0	99.7	2.0	1.9
May 27—						
1 A. M.	0.1	99.9	99.8	99.9	2.0	1.9
2 "	1.7	0.1	0.1	99.7	1.7	1.8
8 "	1.2	0.6	0.6	0.8	1.9	1.9
4 "	......	......	......	......	......	......
5 "	1.5	0.1	99.8	0.2	1.9	1.4
6 "	1.5	0.0	0.4	99.9	1.0	1.6
7 "	0.9	0.2	99.9	0.5	1.2	1.7
8 "	......	......	......	......	......	......
May 31—						
4 P. M.	0.5	1.6	1.2	0.6	2.4	2.0
5 "	1.1	1.9	1.2	1.4	2.6	2.1
6 "	0.8	1.7	1.2	1.2	2.8	2.5
7 "	1.6	1.6	1.6	1.4	2.8	2.4
8 "	0.8	0.6	1.1	1.4	2.6	2.4
9 "	0.7	0.0	0.4	0.4	2.5	2.8
10 "	0.9	0.6	0.8	0.0	2.4	2.5
11 "	0.6	0.5	0.6	99.2	2.2	2.0
12 Midnight	0.2	0.2	1.0	99.4	2.8	2.8
June 1—						
1 A. M.	0.4	99.8	1.0	99.1	1.9	2.5
2 "	......	......	......	......	......	......
8 "	0.2	99.0	0.4	99 2	0.6	1.0
4 "	0.2	0.2	0.4	99.4	1.8	1.6
5 "	0.2	99.6	0.8	99.0	1.5	1.5

TABLE V.—Continued.

ures of Tuberculous Cows and Their Offspring.

	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 36.	Calf of 14.	No. 18.
....	99.8	99.7	0.0	99.2	2.2	1.3	2.1
....	0.1	99.3	0.1	99.6	1.8	1.4	2.0
....	0.3	99.7	0.3	0.8	1.8	1.4	1.5
....	0.8	0.5	0.4	0.9	2.0	1.7	2.8
....	1.0	0.8	0.9	1.0	1.8	1.8	2.5
....	1.3	1.0	0.6	1.2	1.8	1.7	3.2
....	1.2	1.2	0.8	1.2	2.2	1.5	3.8
....	0.9	0.4	0.4	1.2	1.8	1.5	4.2
....	1.2	1.0	0.9	1.6	1.6	1.8	4.7
....	W. 1.9	W. 2.1	W. 1.6	W. 2.1	2.0	1.9	W. 4.5
....	2.5	1.8	1.5	1.9	2.4	1.8	4.0
....	1.8	1.7	1.2	1.6	2 4	2.3	3.9
....	1.9	1.8	1.7	1.5	2.5	2.4	3.3
....	1.8	1.8	1.4	1.8	3.0	2.2	2.8
....	0.6	1.2	1.4	0.5	2.8	2.6	2.8
....	0.8	1.1	1.3	0.4	2.6	2.3	2.3
....	....	....	....	....	....	....	....
....	0.6	0.6	1.0	0.4	2.0	0.1	2.6
....	....	....	....	....	....	....	....
....	99.7	0.1	0.5	99.7	2.8	1.8	2.7
....	99.7	0.2	0.2	0.3	2.3	1.8	2.9
....	0.5	99.7	0.7	99.7	2.5	1.8	2.5
....	0.4	0.0	0.2	99.8	1.3	1.5	2.7
....	0.6	0.0	99.7	99.9	1.7	1.6	3.0
....	0.0	99.5	99.6	0.2	1.4	1.2	3.2
....	98.8	0.1	0.0	0.3	1.5	1.7	2.6
....	0.6	0.8	1.0	0.8	1.8	1.7	2.8
....	0.6	1.2	1.1	1.3	1.6	1.7	3.0
....	1.0	1.0	0.7	1.2	2.0	1.6	3.5
....	0.7	0.4	0.8	1.4	1.6	1.7	3.7
....	1.3	0.6	0.7	0.4	1.8	1.7	4.2
....	1.6	1.1	0.8	1.5	1.6	1.8	4.6
....	0.9	0.9	0.7	1.0	1.8	1.8	4.3
....	1.5	1.1	0.5	1.1	1.9	1.9	4.5
....	1.4	99.6	1.0	1.2	2.1	2.2	3.8
....	1.2	1.2	0.6	1.2	2.0	2.2	3.8
....	1.2	1.2	0.8	1.2	2.1	2.2	3.4
....	1.1	1.1	1.3	1.6	2.6	2.9	2.6
....	0.6	0.5	1.1	0.8	2.8	2.8	2.5
....	1.0	0.2	1.0	99.8	2.4	2.8	2.4
....	0.0	0.4	0.5	99.2	2.5	2.4	2.1
....	0.0	1.0	99.5	99.7	2.2	2.2	2.0
....	....	....	....	....	....	....	....

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offs

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
June 3—						
1 A. M.	.....	.....	.....	.....	.....	.....
2 "	0.5	0.8	0.4	99.4	1.9	2
3 "	.....	.....	.....	.....	.....	.....
4 "	0.0	0.1	0.1	99.1	1.4	1
5 "	1.7	0.0	0.0	99.7	1.2	1
6 "	0.5	0.8	1.0	99.6	1.8	1
7 "	99.8	0.2	0.5	99.7	1.1	1
8 "	.....	.....	.....	.....	.....	.....
June 7—						
4 P. M.	1.4	1.6	1.5	99.7	1.5	1
5 "	0.5	0.8	1.4	0.2	1.9	1
6 "	0.9	0.9	1.2	0.8	1.9	1
7 "	0.9	0.6	0.6	0.6	1.9	2
8 "	1.8	0.4	1.2	0.4	2.7	2
9 "	0.9	0.8	1.0	0.4	2.0	2
10 "	.....	.....	.....	.....	.....	.....
11 "	1.0	0.8	0.8	0.7	2.1	2
12 Midnight	.....	.....	.....	.....	.....	.....
June 8—						
1 A. M.	1.8	0.6	1.0	0.8	2.0	1
2 "	.....	.....	.....	.....	.....	.....
3 "	0.0	0.0	1.0	99.7	1.4	1
4 "	1.0	0.4	1.1	99.8	1.6	1
5 "	1.0	0.2	0.8	99.7	1.8	1
6 "	0.8	0.2	0.8	0.8	1.6	1
7 "	1.8	0.8	0.8	1.1	1.4	1
8 "	0.4	0.6	1.0	1.0	1.9	2
9 "	0.6	0.8	1.2	1.1	1.8	1
10 "	1.6	1.8	1.8	1.1	2.2	2
11 "	1.6	1.9	1.1	0.7	2.1	2
12 M.	1.8	1.2	1.1	1.1	1.9	2
1 P. M.	1.9	0.9	1.0	0.7	1.9	2
2 "	1.4	1.0	0.6	0.9	1.8	2
3 "	2.8	0.1	0.4	0.6	1.9	2
4 "	3.1	1.1	1.1	1.2	1.9	1
5 "	3.0	1.2	0.8	1.4	2.8	2
6 "	2.6	1.8	1.2	1.6	2.0	2
7 "	3.1	1.8	1.6	1.9	2.4	2
8 "	W. 2.0	W. 0.6	W. 1.8	W. 1.4	2.8	2
9 "	1.5	1.0	1.0	0.7	2.2	2
10 "	.....	.....	.....	.....	.....	.....
11 "	.....	.....	.....	.....	.....	.....
12 Midnight	.....	.....	.....	.....	.....	.....

TABLE V.—Continued.

...ures of Tuberculous Cows and Their Offspring.

No. 59.	No. 72.	No. 15.	No. 14.	Calf of 96.	Calf of 14.	No. 18.
1.9	99.2	0.2	99.8	1.8	1.5	8.6
1.4	0.0	1.0	99.8	2.1	1.8	8.4
1.2	0.4	0.7	99.6	1.6	1.8	2.7
0.1	99.8	0.7	99.2	1.2	1.4	2.9
1.0	99.2	99.8	99.2	0.8	1.0	2.6
1.8	99.8	99.6	98.6	1.0	0.9	2.7
0.6	0.2	0.1	0.1	1.8	0.6	2.6
0.2	0.2	0.8	0.2	1.8	1.8	2.6
1.6	1.6	1.1	0.8	1.6	1.8	2.9
1.0	0.7	0.9	0.7	1.7	1.1	8.8
1.7	0.8	0.6	0.8	1.8	1.0	4.1
1.6	0.5	0.9	1.2	1.4	1.5	4.8
1.6	0.6	0.7	0.8	1.4	1.6	4.8
1.9	0.4	0.8	1.4	1.4	1.7	4.6
W. 2.6	W. 1.2	W. 1.6	W. 2.6	1.2	1.7	W. 4.5
2.8	1.0	0.7	1.0	1.8	2.1	4.6
2.8	0.8	0.9	1.8	1.9	1.8	4.8
2.6	1.4	1.6	1.9	2.8	2.4	8.6
2.8	1.4	1.6	1.7	2.2	2.8	8.9
2.8	0.8	1.1	1.4	2.6	2.4	8.7
2.2	0.8	1.2	1.8	2.1	2.0	8.6
2.0	0.6	1.7	1.0	1.8	1.7	8.7
....	....	....	....	....	....	....
....	....	....	....	....	....	....
1.9	0.8	0.7	0.2	1.2	0.9	8.2
1.5	0.0	0.2	0.8	0.9	1.1	2.8
1.6	99.6	0.5	9.5	1.0	1.4	2.6
....	....	....	....	....	....	....
0.7	99.0	0.6	0.4	0.9	1.2	1.8
99.4	99.0	0.8	0.2	0.9	0.9	1.9
1.2	0.2	0.6	0.6	1.8	1.4	2.7
0.7	0.4	99.7	0.8	1.8	1.8	2.6
0.6	1.0	0.8	0.8	1.5	1.8	2.7
1.7	0.7	0.6	1.0	1.8	1.4	8.0
1.4	0.6	1.1	1.2	1.6	1.4	8.8
1.8	0.8	0.8	0.8	1.9	1.6	8.8
2.5	0.7	1.8	0.8	1.4	1.7	4.4
2.6	0.6	0.2	1.1	1.8	1.9	4.6
8.8	1.1	1.8	0.6	1.4	1.8	4.7
W. 8.9	W. 2.1	W. 1.9	W. 2.9	1.4	2.1	W. 5.0
8.8	1.6	1.6	1.6	2.1	2.5	5.0
8.7	1.8	1.8	2.5	2.6	2.4	4.8

TABLE V.—Continued.

Temperatures of Tuberculous Cows and Their Offsp

DATE.	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 95.	Calf of 14.
1901.						
June 10—						
7 P. M.	3.3	2.2	1.6	2.2	2.2	2.6
8 "	3.4	1.6	1.2	1.7	2.6	2.6
9 "	2.5	99.8	0.8	1.2	2.3	2.4
10 "	1.3	1.5	1.3	1.1	2.5	2.4
11 "	2.1	1.0	1.0	1.5	3.0	2.4
12 Midnight	......	......	......	......	......	......
June 11—						
1 A. M.	2.7	0.6	0.3	0.3	1.4	2.0
2 "	2.3	1.2	99.9	0.4	1.5	2.0
3 "	......	......	......	......	......	......
4 "	2.0	0.6	0.6	99.6	1.6	2.0
5 "	0.8	0.6	1.0	99.8	1.0	1.7
6 "	0.4	1.0	0.7	0.5	1.5	1.
7 "	0.6	1.0	0.7	0.8	1.2	1.
8 "	1.3	0.7	0.7	0.7	1.5	1.
Minims inje'd at 5 P. M.	65	90	55	70	16	20
June 15—						
9 A. M.	3.0	1.6	1.5	2.1	2.2	2.
10 "	3.6	1.5	1.3	1.9	2.1	2.
11 "	3.1	99.8	0.8	0.3	2.0	2.
12 M.	1.7	0.5	0.5	99.7	1.1	2.
1 P. M.	1.9	1.0	1.0	98.4	1.2	1.
2 "	o. 0.1	o. 0.0	o. 99.1	o. 0.2	o. 0.7	o. 1.
3 "	o. 0.2	o. 0.4	o. 1.0	o. 99.6	o. 1.0	o. 1.
4 "	n. 1.2 o. 0.6	n. 99.4	n. 99.4	n. 98.8 o. 97.4	n 1.4 o. 0.4	n. 1. o. 0.
5 " (Inj.)	n. 1.5	n. 0.6	n. 0.8	n. 0.2	n. 2.0	n. 1.
6 "	1.9	1.2	1.0	0.6	1.7	2.
7 "	2.6	1.4	0.4	0.0	2.4	2.
8 "	2.4	1.2	1.1	0.9	2.4	2.
9 "	3.3	0.0	1.7	99.7	2.5	2.
10 "	3.6	3.4	0.5	0.0	1.8	2.
11 "	......	......	......	......	......	......
12 Midnight	3.5	0.6	0.6	99.7	1.8	2.
June 16—						
1 A. M.	......	......	......	......	......	......
2 "	2.4	0.2	1.6	99.4	1.9	2.
3 "	2.4	0.6	1.2	0.2	1 9	2.
4 "	2.0	0.0	0.0	0.2	1.5	1.
5 "	2.0	99.0	0.2	98.3	1.2	1.
6 "	2.3	99.4	0.3	99.6	1.3	1.
7 "	1.7	99.8	0.3	0.0	1.8	1.
8 "	2.4	1.0	0.5	0.3	1.6	1.

TABLE V.—Continued.

ures of Tuberculous Cows and Their Offspring.

	No. 59.	No. 72.	No. 15.	No. 14.	Calf of 35.	Calf of 14.	No. 18.
...	2.5	1.0	0.6	0.6	2.0	2.1	8.8
...	2.9	1.0	1.0	1.2	1.8	1.9	8.6
...	2.7	1.8	0.9	1.5	1.8	1.8	8.6
...	8.0	1.6	1.1	1.5	1.7	1.8	4.0
...	8.5	1.4	1.2	1.5	1.6	1.8	4.8
...	W. 8.0	W. 1.5	W. 2.2	W. 2.8	1.8	1.6	W. 8.8
...	2.4	1.6	1.2	0.6	2.0	1.9	8.8
...	2.8	1.8	1.1	0.7	2.0	1.8	4.1
...	2.6	0.7	0.8	1.1	1.9	1.9	8.8
...	2.8	1.0	1.1	1.2	1.9	1.7	8.7
...	2.4	1.2	1.1	1.5	2.4	2.5	8.4
...	2.7	1.0	(?) 1.7	1.6	2.8	2.0	8.4
...	2.4	0.6	1.4	0.8	1.6	1.8	8.4
...	....	....	....	....	....	....	....
...	....	....	....	....	....	....	....
...	1.1	99.1	1.0	0.2	1.5	2.0	2.9
...	1.9	1.4	1.4	0.2	1.4	1.2	2.4
...	....	....	....	....	....	....	....
...	1.2	1.9	1.5	0.0	0.4	1.1	2.5
...	1.2	0.0	1.0	99.2	0.4	1.0	2.4
...	0.9	0.1	1.0	98.7	0.5	0.6	2.2
...	1.5	0.1	0.6	99.4	0.4	0.6	2.1
...	1.8	99.5	99.8	99.8	0.7	0.4	2.1
...	1.8	0.4	0.8	0.0	0.8	0.8	2.5
...	2.1	1.5	0.9	1.7	1.4	1.2	8.2
...	2.1	1.2	1.1	2.1	1.4	1.6	8.2
...	2.2	1.8	1.2	1.4	1.4	2.0	8.8
...	2.4	1.5	2.5	1.4	1.8	1.6	5.0
...	2.6	2.8	8.4	2.2	1.4	1.6	5.0
...	8.2	2.2	4.2	2.1	1.2	1.7	4.7
...	8.5	8.1	4.2	2.4	1.4	2.0	5.0
...	4.0	2.8	8.0	2.2	1.7	2.2	5.2

REPORT OF BOTANIST.

REPORT OF THE BOTANIST.

r ending November 30th, 1901, the work in the Botan-
ent has been largely upon the two acres of the Experi-
the College Farm, supplemented with studies in the
d field work in various parts of the State.

past eight years the experiments in the field have been
d to truck crops, with less attention to tests of fungi-
e to the breeding of varieties of corn, beans, eggplants,
umbers, squashes, etc.

h a white and a black variety of sweet corn in 1899, a
f the two has resulted in a few instances, the present
that were entirely with red grains. At the same time
ints in plant-breeding have been obtained.

g of a yellow variety of tomato with a red one has re-
ducing plants of remarkable vigor and a blending of
may be of much profit. One of the results is a number
t are remarkable for healthy vine and fruits that are
s.

f combining two varieties of dwarf lima beans has re-
mproved sort that is very promising. In this connec-
e been reversions to the pole type that with these new
rove advantageous.

mmediate results in the crossing have been with the
l a new form has developed that may surpass all others
ble qualities in this vegetable fruit. All the crosses
nd productiveness of plant that is very gratifying.

rs the progress in breeding for a spineless fruit has pro-
y types are reached but none are fixed.

ses are showing some features of interest.

of salad plants has been continued and the Swiss Chard
and spinach have shown much to recommend them for

salsify has bloomed and fruited this season and a good
s for testing the quality of the roots next year is now
nd.

s upon the asparagus rust have been continued and

additional facts determined with regard to its spread thro
United States and its dependence upon the prevailing chara
of the weather.

As usual the work with weeds has been the identificatio
stuff in commercial seeds and the observations upon the we
which has been maintained for several years in a wild co
The finding of broom rape upon clover and another speci
tomato are some of the weed events of the year.

A new greenhouse, 24 by 80 feet, was used for the first t
winter, and in it some results were obtained in germination,
larly as to albinism in corn, the dimorphism in buckwheat
checking of mildews with various fungicides.

Some studies were made of the dodders, which as parasiti
are often serious pests to clover, flax and other field crops.

One bulletin has been issued from this department since
annual report was published; namely, June 1st, 1901, Bulle
"Bean Diseases and Their Remedies," with four page plat
figures and twenty-eight pages.

The Station Herbarium has grown with the usual annual ac
from various sources.

In its many details the work at the Experiment Area and
greenhouse has been, as formerly, in charge of Mr. J. A. Kel
any success in results in crossing and spraying is largely du
faithfulness.

The Experiment Area.

In the accompanying plan, Figure 1 shows the method of
the two acres known as the Experiment Area; it also locate
plots the various crops that have occupied the ground the
season.

The seven series from 0 to VI. run up and down a slight in
the field and are separated by four-foot paths, while the fo
33 by 66 feet, in each series extend right and left of the
page.*

To improve the soil, naturally a gravelly clay underlaid w
low gravel, stable manure at the rate of twenty tons per a
been added each spring during the past seven years. Last
nearly all the plots were sown to rye after the regular crop
moved. This made a good live cover that helped to hold the
soil from washing in winter, but grew too rapidly in the spr
that barley is used instead this season.

* The plotting is given in full detail in the report for 1894, p. 279.

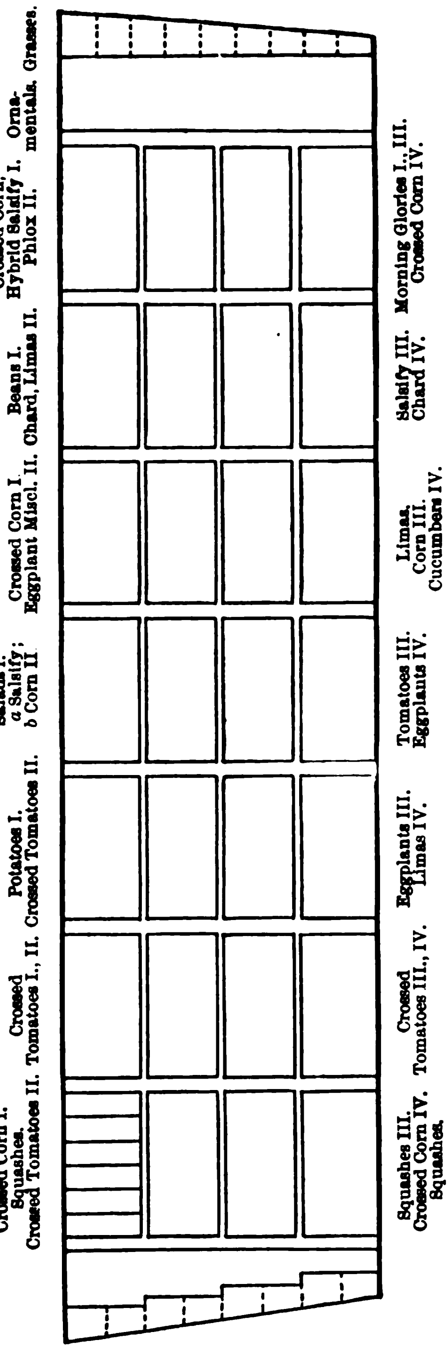


Fig. 1. The Experiment Area in 1911.

EXPERIMENTS WITH TURNIPS—Concluded.

Series I., that had been in turnips for seven years, was set t
to crossed tomatoes. First, because the demonstration was m
lime is a satisfactory remedy for the club-root; secondly, tu
not thrive as a continuous crop for many years, and thirdly
to the limited space, the land was needed for other experime
The reader who is interested in the club-root experiments
were the chief reason for holding turnips for seven years an
consecutive crops upon the same land, will find the tabulati
conclusions upon pages 410–413 of the report of this depart
last year.

POTATO EXPERIMENTS IN 1901.

Only Plot I., Series II., was in potatoes the present seas
this for the seventh consecutive year. The continuous croppi
potatoes is not advisable and was only indulged in for the sak
experiments with soil fungicides for the scab. The results h
been uniform in these experiments, and while sulphur gav
promise the tests need to be many upon various kinds of soil
final judgment is rendered in the case. Owing to the dem
other lines of field experiments, mainly with plant breeding,
with potatoes must for a time be considerably curtailed.

Last season it was found that a shavings mulch gave a g
the adjoining uncovered land of nearly as 5 to 3. With this
and the fact that the mulch seemed to protect the potatoes fro
it was concluded to continue Plot I., Series II., in potatoes, a
for the seventh crop, which would very surely be a small on
early part of the season was unfavorable for potatoes and
throughout the State is only a fraction of the average.

The upper third of the plot was mulched with shavings
purchased in bales of 100 pounds each and used for stable b
Fresh shavings to the depth of two inches were applied in Ju
thereafter no cultivation was given to this portion of the plot.

The harvest was upon October 8th, and the following tabl
the results in number of marketable potatoes, weight of the sa
number of hills:

		Belt 1.	Belt 2.	Belt 3.	Belt 4.	Belt 5.	Bel
Potatoes	Mulch	24	28	40	40	27	2
	No Mulch	76	36	78	45	47	2
Weight	Mulch	6¾	5½	11½	10¾	7	
	No Mulch	17½	6½	17¾	11¼	9¼	
No. of hills	Mulch	14	18	19	19	19	1
	No Mulch	34	35	36	34	37	3

es upon mulched ground 180, and upon the unmulched bringing the two portions to the same size the relative for the mulched soil 360 and the unmulched 310. The ts became for mulched land 91 pounds and 67¾ for d ground, a difference of nearly a half in favor of the

ng table is of the amounts of scab, estimated as in in terms of per cent. :

	Belt 1.	Belt 2.	Belt 3.	Belt 4.	Belt 5.	Belt 6.	Average.
....	65	40	70	45	45	5	45
d.................	50	50	75	70	60	60	61

at the mulched land shows less scab, which may be due forming nearer the surface of the soil, sometimes even where there may be fewer scab germs.

EXPERIMENTS WITH BEANS.

ies V., has been continuously in bush beans since the rea was started in 1894, with two crops for each ing for the present year. Only two sorts, namely, olet" and "Saddleback Wax," were grown, they being ernate rows upon May 16th. On account of the cold, hortly after planting, the stand was not good with the rt and the rows of the other were somewhat broken.

30th it was recorded that there was much bacterial e "Green Flageolet." This is among the most suscep- e bush beans to this disease, but the alternate rows of ck Wax" were not exempt. This last-named variety clined to the blight, and this selection of the extremes ty was purposely made in order to study this obscure

examinations were made of the leaves and other parts ieties, but enough evidence is not yet found to warrant n as to the exact reason for the great susceptibility in nd comparative immunity in the other.

a natural cross between the two sorts, by growing them was not realized, and the demonstration is made that, ke beans, where close fertilization is easy, and possibly must resort to castration and the other accompanying d pollination to secure a cross. Beans, peas and plants

of that class are very different from corn, which crosses so that difficulty lies in keeping a variety pure when grown a near another variety.

In another part of the Experiment Area, where the s crosses between the two above-named varieties of beans of l were grown this season, there was considerable of the bean-p (*Colletotrichum lagenarium* Pass.) upon the "Saddleback This is interesting as showing that this disease may appear piece of land after it has been almost entirely absent for som

There was no record made of the yield of the two varie comparative productiveness having been fully determined in years. The crop was such, however, as to confirm the opi pressed before, that, under good culture and a fair degree of ing, bush beans may be grown upon the same soil for at lea years, with two crops in each season.

EXPERIMENTS IN CROSSING LIMA BEANS.

Last year twenty plants were secured as crosses between the derson" and "Burpee" types of dwarf limas. The seeds this score of plants were planted this year and the results recorded.

In a general way, it may be said that the vigor of the pl satisfactory. There were many individual differences from the seedlings unfolded their first true leaves, and the plot those evidences of a mingled blood that plant-breeders find cult to set down in words. Some rows, that is, plants f parent, were more uniform than others, favoring the "Hen or the "Burpee" as it might be. As they increased in age hundreds remained true to the dwarf type excepting seven pla those were given poles and climbed, with one exception, vigor characteristic of genuine pole beans. It remains to b mined what the progeny may desire to do. In passing, it said that the future of these climbers is full of interest, represent a combination of qualities that may be of commer portance. These plants are treated separately elsewhere.

In fruitage there is a remarkable constancy for all the twe of plants adhere when quite closely to a type of pod and s make it easy to distinguish them from either of the crosses not necessary to repeat in full the statement made in the last year, where a full page plate was employed to exhibit t

th the pods of the two parents placed along side. e introduced will serve to show the characters of in a small quantity of each.

come this season to test the quality of the cross, avorably with that of the "Burpee" and is far the other parent. While not as large a seed as is large enough for a lima, and, when its yield is l grower should be pleased with it.

the result of the crossed plants for the year. Some only a few seeds last season and those from two out d to produce plants this season :

	No. of Plants.	No. of Ripe Pods.	No. Green, Filled.	No. Green, Empty.	Total.
....	Failed	....	....	....	....
....	2	2	35	3	40
....	3	13	37	....	50
....	1	5	11	....	16
....	19	425	46	5	476
....	20	592	65	18	675
....	70	1,200	325	40	1,565
....	1	9	17	....	26
....	72	1,227	338	95	1,660
....	32	775	85	40	910
....	33	570	55	21	646
....	5	193	44	....	237
....	29	705	305	25	1,035
....	28	940	165	15	1,120
....	46	995	131	10	1,136
....	Failed	....	....	....	....
....	21	332	25	10	357
....	69	1,597	312	80	1,989
....	16	560	210	30	800
....	5	96	35	10	141
....	472	10,236	2,241	40s	12,879

nber of pods to a plant is 27.

plot of ground was devoted to alternate rows of eties and these harvested the following :

	No. of Plants.	Ripe Pods.	Green Pods.	Empty Pods.	Total.
....	369	449	1,056	620	2,125
....	700	3,550	340	350	4,240

ne "Henderson" produces about twice as many pee" upon a given area, and this is due to the

fact that the plants are smaller and may be grown closer t
Another fact is the earliness of the "Henderson," for four-
the pods were mature, while less than one-fourth were ripe in
of "Burpee" plants. The average was six pods to a plant.

With the crossed plants, while the yield was 27 pods pe
the matured pods made up five-sixths of the crop and the emp
one-thirty-second of them all. In short, while the productiv
more than four times that of the parents, the earliness is a
the "Henderson."

The relative size of the beans is well shown in the en
(Plate I.), and the cross is seen to be nearer the "Burpee
the "Henderson." In quality the same is true, and, while
"rich" as the "Burpee," it is nearer to it in this important
than the "Henderson."

The following eight plants were pole beans:

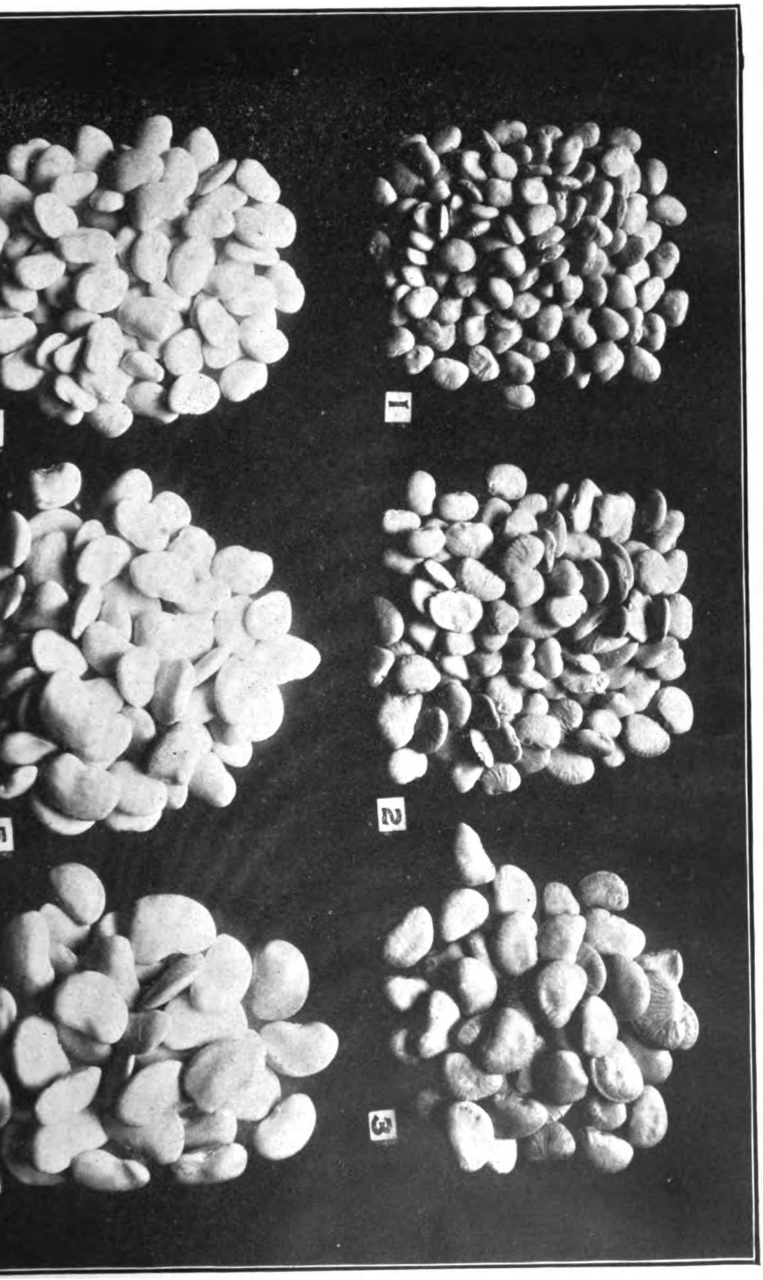
Parent.	No. of Plants.	Ripe Pods.	Green Pods.	Green, Empty.	Tot
13....................	1	24	2	14	
12..	2	64	35	107	2
15..	2	61	130	60	2
18..	1	23	42	57	1
20..	2	209	355	132	6
	8	381	564	370	1,3

The two from the parent plant No. 20 are remarkable in th
large yield, one of them giving 404 pods and the other 292.
are valuable stock for further growth, as these and all the ot
plants are, of course, not like the parents, and become the
points for new lines of breeding possible for pole limas.

EXPERIMENTS IN CROSSING TOMATOES.

Tomatoes were given much attention and space in the Exp
Area. From the large number of lots of seed saved from
plants of the previous season the following were chosen fro
fruited plants: numbers 6, 7, 17, 25, 32, 33, 52, 62, 84, 92, 9
144, 150, 168, 176, 178, 182, and from yellow-fruited plant
bers 98, 112, 113, 122, 125 and 126. The performances o
parent plants are given in full upon pages 431 to 439 of the
for 1900.

The whole of Series I. was devoted to the seedlings of these
and Plots I., II. and III. received the above numbers 6 to 1


1
2
3

ix numbers 98 to 126. There were, therefore, three
its from red fruits and one plot with plants from yellow
parent number was assigned to a belt and was repre-
plants.

ig table is made up from the results of each set of

		Range of Fruitfulness.	Average Fruitfulness.	
d) No.	6	48 to 120	84	Two Yellow.
	7	57 " 125	98	" "
	17	47 " 110	78	" "
	25	45 " 128	84	No "
	32	39 " 130	81	Two "
	33	72 " 139	102	One "
	52	50 " 102	79	No "
	62	29 " 110	65	One "
	84	17 " 125	79	No "
	92	40 " 72	64	" "
	97	42 " 133	73	" "
No.	104	51 to 131	90	No Yellow.
	144	58 " 143	85	" "
	150	51 " 188	108	One "
	168	28 " 103	63	" "
	176	66 " 99	78	No "
	178	65 " 140	96	One "
	182	48 " 179	103	" "
ellow) No.	98	43 " 92	61	Two Red.
	112	31 " 105	60	No "
	113	29 " 81	56	" "
	122	40 " 66	54	" "
	125	36 " 101	63	" "
	126	22 " 139	75	" "

earing the yellows, is perhaps the least congenial soil
and this may account for the somewhat smaller average
ix lots of plants. The following table shows grand
ie four plots :

		Average.
....	64— 90	77
....	78—102	90
....	63—108	85 5
....	54— 75	64.5

ord of each of the 240 plants, considered in brief above,
, in which the time when each fruit was picked is given
ess or lateness of the plant, along with its productive-
itter for reference.

Plant No. 67 of the 1900 crop was from a seed of a red fru
ing from a cross of "Golden Sunrise" upon the "Dwarf Cha
and with a record of 83 fruits, all of which were below aver
but nearly free from seeds. The plant was unusually large
orous, so that it was dubbed "Giant," while the foliage ha
tled appearance, as if the differing green of the two parents
fully blended.

Thirty-seven seedlings from the fruits of this unusual pl
set in Plot II., Series II., and the following is the record of
for each :

	August.				September.				October.		Ripe.	Green.	Total.	Color.	Foliage, &c.
	10	17	24	31	7	14	21	28	5	25					
No. 1											0	0	0		Thin. (See Pl. II.)
" 2							2				2	0	2		Normal.
" 3				1			2	1	3	1	8	0	8	red.	Thin.
" 4											0	0	0		Potato-like. (Pl. II
" 5							1		1		2	2	4	red.	Fruit plum-shaped.
" 6							1			1	2	7	9	red.	
" 7							7	3	2	4	16	25	41	yellow.	Rank growth.
" 8								1	3	9	15	17	30	red	
" 9								2	4	4	10	20	30	red.	
" 10									3		3	0	3	red.	
" 11		1								3	3	4	7	red.	
" 12											0	0	0		
" 13											0	0	0		Erect, bushy. (Pl.
" 14			2		21	9	28	14	9	14	96	60	155	red.	
" 15											0	0	0		
" 16	1		1		4		11	5	6	4	32	0	32	red.	
" 17					1		11	10	5	8	35	0	35		
" 18		1		1	16	8	30	14	10	14	94	45	139	yellow.	
" 19			5	1	16	11	44	16	12	10	115	42	157	yellow.	
" 20		7	2	4	21	4	46	29	8	5	126	8	134	yellow.	
" 21							22				22	37	59	red.	
" 22		2		6	7	2	15	11	2	4	49	0	49	yellow.	
" 23					14						14	0	14	red.	
" 24			1	3	19	25	65	80	120	80	393	13	406	red.	"Dulcamara." (Pl.
" 25				10		13	33	20	6	3	85	13	93	yellow.	
" 26												6	6		
" 27												4	4		
" 28				7	7	2	2	9	20	10	57	13	70	red.	
" 29				1	6	6	14	5	12	8	52	18	70	red.	
" 30			1			1	3	7	13	2	31	2	33	red.	
" 31				4	8	4	10	4	2	1	33	0	33	red.	
" 32			1	10	12	1	7	2	3	9	54	15	69	red.	
" 33			1		6	3	8		4	6	28	15	43	red.	
" 34					26	2	16	11	13	22	90	22	112	yellow.	
" 35			1		7	3	13	4	5	16	49	40	89	red.	
" 36			3	3	15	1	15	3	2	2	44	4	48	yellow.	
" 37			3	3	7		10	9	10	4	46	8	54	red.	

PLATE II.

s in Tomatoes—seedlings of No. 67. Stems and leaves. No. 1, a fine nine-leaved,
No. 4, a potato-like fruitless plant. No. 5, an upright plant with plum-like fruit, nearly
, a rank-growing plant. No. 13, erect-bushy fruitless plant. No 24, a fine-leaved
, with small cherry fruit.

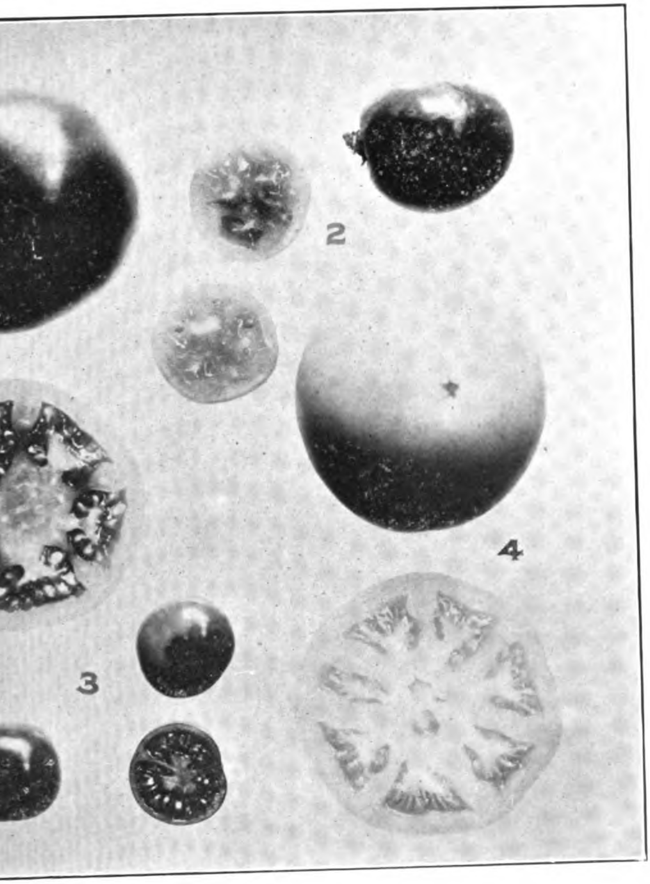
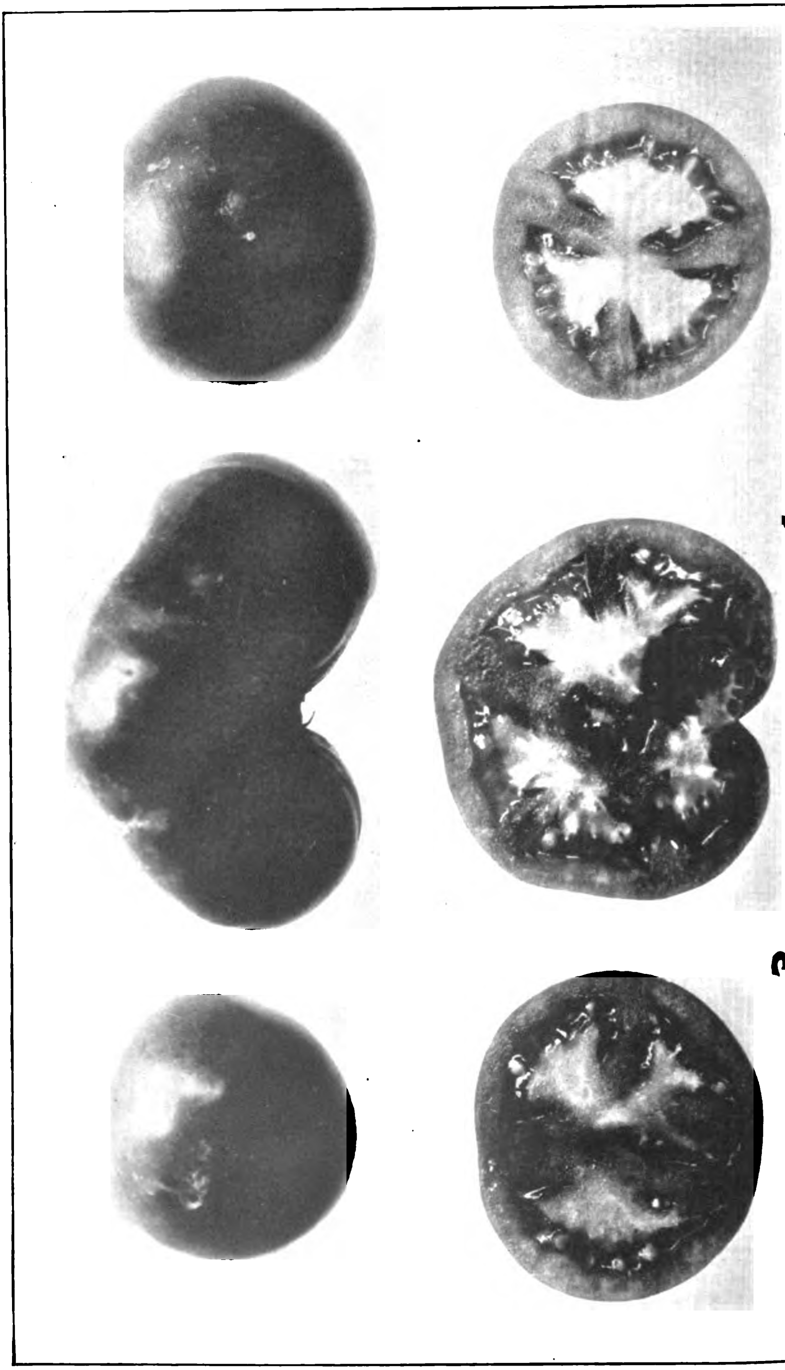


PLATE II.

Tomatoes—No. 1, an average red fruit, also in sectional view. No. 2, plum-shaped
d flesh. No. 3, the cherry tomato, with many seeds. No. 4, a type of the yellow
view of same.



at the number of fruits ranged from 0 to 406, ten were six were over a hundred. Some showed marked earli- ured all their fruits, as Nos. 16 and 17, while others los. 7, 18 and 35. Plate II. shows variations in the it of this lot of tomatoes.

7 of the 1900 crop was from a seed of a red fruit re- cross of "Golden Sunrise" upon "Dwarf Champion," f only 27 fruits, all small and with the seeds ranging ix to a fruit. This plant was remarkable for its great above the surrounding plants. The flowers were of e size and added to the gigantic appearance of the

e seedlings from this plant were deformed and failed size, and only five specimens were set in the field, with esults :

4.	Sept. 21.	Sept. 28.	Oct. 5.	Oct. 25.	Total ripe.	Green.	Total.	Color.
.	1	2	1	8	12	4	16	red.
.	.....	2	2	1	5	1	6	red.
1	3	.....	1	3	8	22	30	red.
..	2	1	1	9	13	12	25	red.
.	5	4	9	3	21	12	33	red.

were of fair size and many of them had but few seeds. photographed for Plate III. were from those that are ause of their comparative seedlessness.

ll fruited late, there being only one fruit picked before , and the yield in all cases was small, ranging from 6 The fruits were all red and of fair size, with a small verage seediness, and the plants were of the spreading pe, although not large.

Tomato Stock Plants.

Plot III., Series III., was kept in tomatoes for the ve time, two rows to each belt, the "Golden Sunrise" hampion" alternating with five plants to a row. The f "Sunrise" in fruitfulness ranged from 55 to 147, e of 91, while the "Champions" ranged from 32 to erage of 61.

r years the "Sunrise" is seen to be much the more , but being yellow is inferior as a market fruit ; but

by those who have overcome the "color impression" the y often preferred. The "Champion" comes into bearing earlie green fruits were excluded from the record there would not l in favor of the "Sunrise."

This crop shows that fair crops of tomatoes may be grown ously upon the same land when the latter is kept in good t the plants are sprayed, and all diseased fruits are promptly from the field.

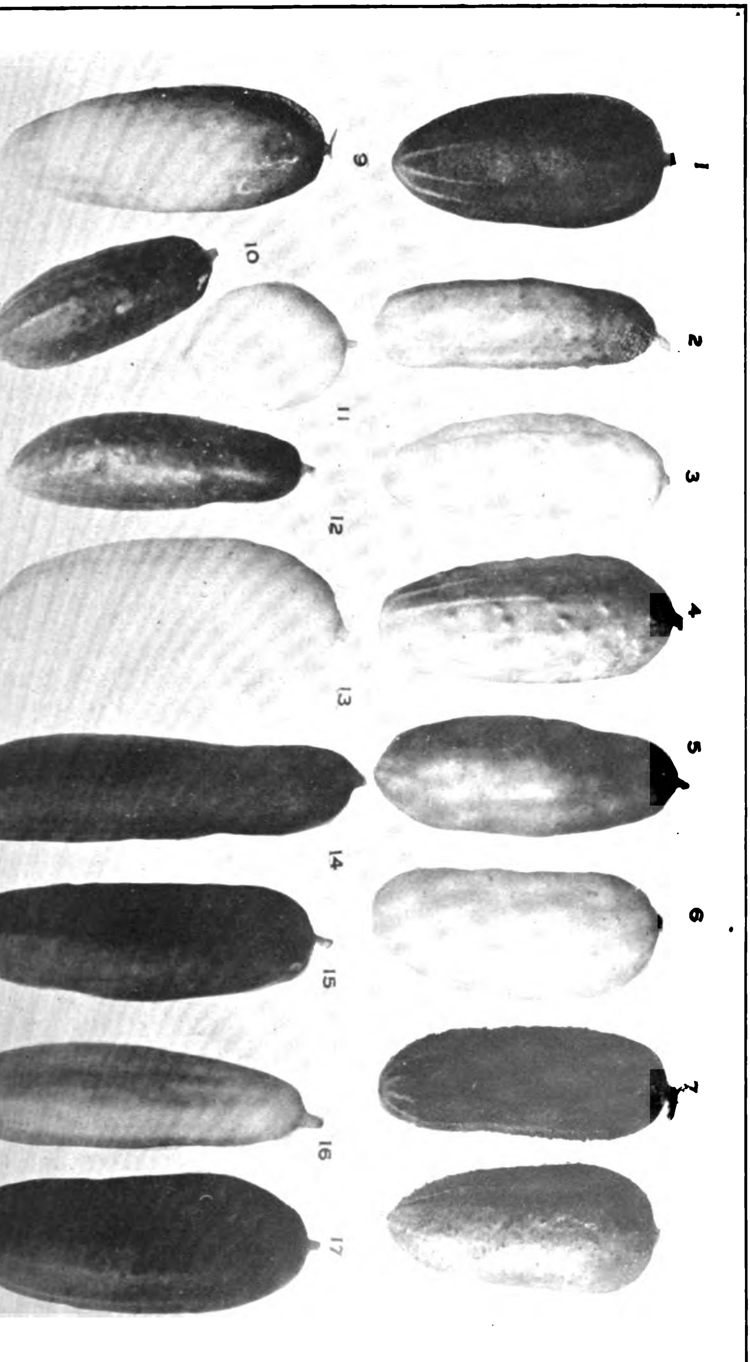
EXPERIMENTS IN CROSSING CUCUMBERS.

From the crosses effected in 1899 between the "White Spin the "White Pearl," twelve plants were grown last season. T acteristics of the fruit of this cross were shown in Plate I report for 1900, along with those of the two parents. Seed fruits of the above cross were used to fill Plot IV., Series I being 36 hills.

Barring the severe attack of the beetles when the plants we and saved from them only by timely vigilance, the use of inse net covers and hand-picking combined, the plants made a fin and exhibited a vigor that was satisfactory. When the fruits a it was at once evident that the plot bore a motley lot of crosse Many of them produced fruits of all degrees of color, from t white to a mottled, middle type and then on through all sh green to the greenest that are produced. In size and shape th tion was no less, for some were nearly round, while others w and slender. The type that was fairly uniform the previous y been broken up in the second generation, quite in keeping w general rule with crossed and hybrid plants.

In the midst of the season several of the more evident marketable size were selected for photographing, and Plate IV the appearance of these in general form, but the shades of g only unsatisfactorily shown.

One of the chief points in mind in this crossing was the re the spines, and this has been quite fully accomplished in s stances, while contrariwise other crossed plants produce remarkable roughness. For example, if one makes a com between Nos. 7 and 8 in the engraving (Plate IV.) with Nos 15, he will be impressed with the spines upon the former a nearly entire absence from the latter.


1
2
3
4
5
6
7
9
10
11
12
13
14
15
16
17

Notes on Cucumbers.

ing are some of the notes made September 5th, upon s shown in Plate IV., taken in order, beginning with

Is a short, roundish specimen, peculiar in having a mottled with white, and the blossom end quite pointed ith white. Nearly spineless.

Is remarkable for its large spines, somewhat curved, n in size throughout, and decidedly triangular in cross y green at stem end, and quite pale-green and ribbed the blossom end.

Is somewhat similar to No. 2 in the number of spines, ish-white throughout, somewhat curved, and decidedly cross section, and larger at the stem end.

Is with few large spines, very straight and plump and A light-green, strongly ribbed with white from the

Has very few small spines. Is larger at the blossom -green throughout, with the exception of a tendency to ed from the blossom end.

Is white throughout, with few spines, very plump and ed.

Is remarkable in being exceedingly spiny. Dark-green growing pale and becoming yellowish-green at the blos- h a tendency to be ribbed and quite triangular in cross

Is nearly the shape of No. 1, but, in addition, is ex- iny, with a strong tendency to mottling, with a light harp-pointed at the blossom end.

Is nearly free from spines. Is broadly boat-shaped, tches of whitish-green upon the green background, with be ribbed from the flower end.

). Is with few spines, and a deep green color through- ly triangular in section.

. Is free from spines, oval-shaped, and white throughout.

2. Is somewhat spiny, long, dark-green, and somewhat

3. Is almost without spines, and white throughout. boat-shaped, nearly straight, and very handsome.

Number 14. Is with few spines. Very dark-green a somewhat club-shaped.

Number 15. Is nearly spineless. Dark-green. Stra form in all respects throughout.

Number 16. Is nearly spineless. Pale, greenish throughout, and inclined to be club-shaped; somewhat section.

Number 17. Is with very few spines. Intensely color, nearly uniform throughout. Slightly curved, a tendency to be triangular.

EXPERIMENTS IN CROSSING EGGPLAN

The results of the first year with seedlings from the "New York Improved Spineless" variety upon the "Lo the previous season have been fully considered the prese greenhouse permitted the growing of plants of variou ting in the experiment grounds. One lot was started some of the plants showed their first bloom before they and an early crop of fruit obtained from these plants, second setting that corresponded in time with the mai grown at the usual time.

The cross was evident at a very early stage in the plants, first, from the uprightness of the "Long Pu with the large broad leaf of the "New York Improved. the purple color of the young stems and leaf-stalk and mon to the "Long Purple," with the stoutness of the Improved." Unusual vigor prevailed in the plants a able freedom from all leaf or root troubles, quite in plants of previous seasons upon adjoining plots. Thi due to a more favorable year for this crop, as is proved plants of both parent forms grown alongside of the cros

When it came to the fruit the certainty of the cross confirmed, because, instead of the long, slender and u form of the "Long Purple," or the oval shape of the Improved," there was a fruit that combined the charac two. In color it agreed closely with the dark purple o Purple," and is perfection in that respect for the pec of the market. In general shape it was like a slend "Bartlett" or "Louise Bonne" type, with often a little feature may be due simply to the position the you

ground upon which it rests and the branch above that hile in weight it may not be heavier than the oval "New ved," it is often nearly twice as long, and therefore of a or shape for cooking. A large "egg" of the oval type uited for the frying pan, while the new cross bears fruits gathered at the right time, are just right for slicing and of the most convenient size for the table. The serious the "Long Purple," as grown here for several years, eir small size and lateness in coming into bearing and fulness. The quality is superior, and the small slices, rly prepared, suggest strongly the oyster without their features to those whose defective digestion is insufficient ve.

g Purple" fruit has the seeds confined to its lower half, ne free or lower end. In the "New York Improved" e more generally distributed throughout the fruit. The a long fruit, from which more than half of the slices taken h, while the others are firm because the seeding tendency y developed.

s of this cross have proved of remarkable vigor, so great, it has been suggested that for this reason alone the cross n. They began to yield marketable fruits by July 20th, August 8th before fruit could be gathered from the "New ved." The crossed plants were practically one month the "New York Improved" and fully six weeks in he "Long Purple." The latter were only beginning to ugust 8th, and marketable fruits were rare until after 0th.

d and parent plants seemed to be equally affected by the

r gain of the cross is in the qualities found in the fruit tioned, namely, its perfect color, its desirable size and exceedingly attractive to the eye and permitting of con- ng for cooking, the large portion without seeds and ne high quality of the "Long Purple," with none of its

nains to be determined whether the cross will maintain years to come. For the present, it can only be said that en but little variation from the shape mentioned. In le lot of eggplants has yielded fruits as uniform as any ndard sorts the writer has seen. This does not preclude

the thought that the second year may see many varia
selection and further breeding may be necessary to fix t
this is found necessary, the attempt will be made to
fruits still more, so that they may stand on end as the
less surface upon the earth to induce decay or attract
at the same time increasing the percentage of seedle
suitable shape for ordinary purposes.

Plate V. shows in the upper half the cross-fruit, i
with the sample of "Long Purple" fruit upon the
"New York Improved" upon the right. It was imm
parent bore the seeds in the cross, as the results were qu
the same. There is little that needs to be said in ad
preceding remarks, for the results are well shown in the

The lower half gives the same fruits cut longitudinall
center, to show the texture and seed-bearing capacity
forms. It is seen that the middle fruit shows a much l
of solid, seedless interior than either of the parents. T
due to the increased size over the "Long Purple,"
parent it received the tendency to freedom from seeds
two-thirds of the fruit.

EXPERIMENTS IN CROSSING SWEET CORN RED GRAINS.

Plot IV., Series VI., was again planted to sweet corn
the pink grains were used from eight ears of the previo
all having over ten rows upon the cob. The planting w
14th, and the fruit harvest September 23d. The wh
remarkable for the vigor and size of the plants, which
the large-sized sweet corns.

The first thing observed in the results of the year's wo
plot is the greatly-increased amount of the red in the ea
below gives the number of grains of each color for five a

	Uncolored.	Black.
	69	21
	35	140
	43	115
	215	110
	82	21
Average	90	81

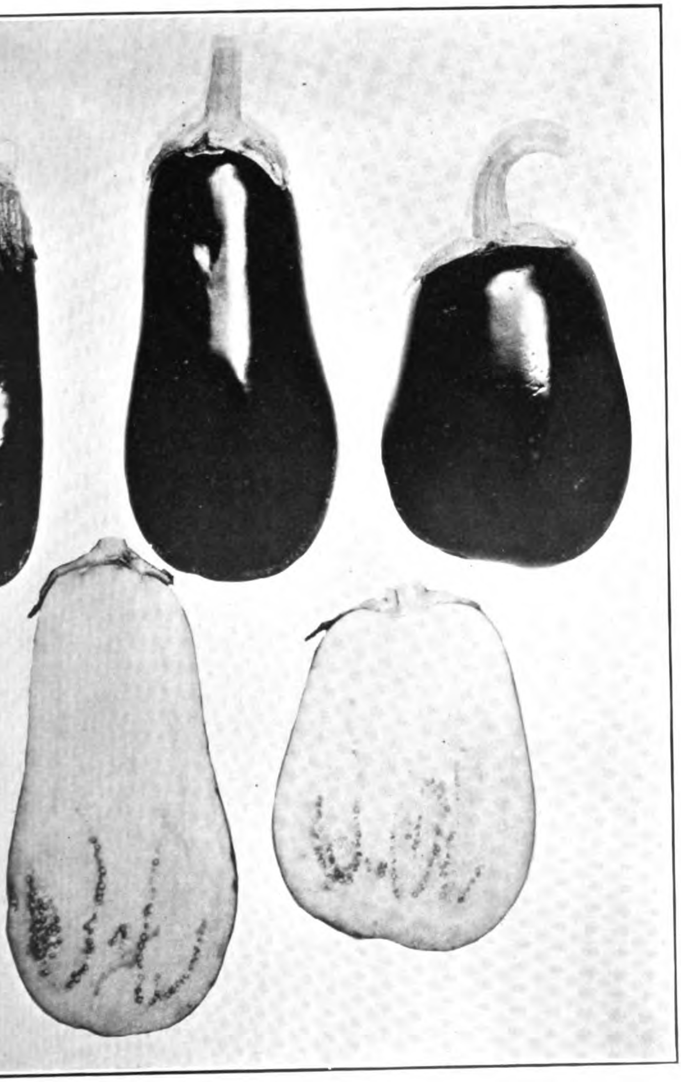
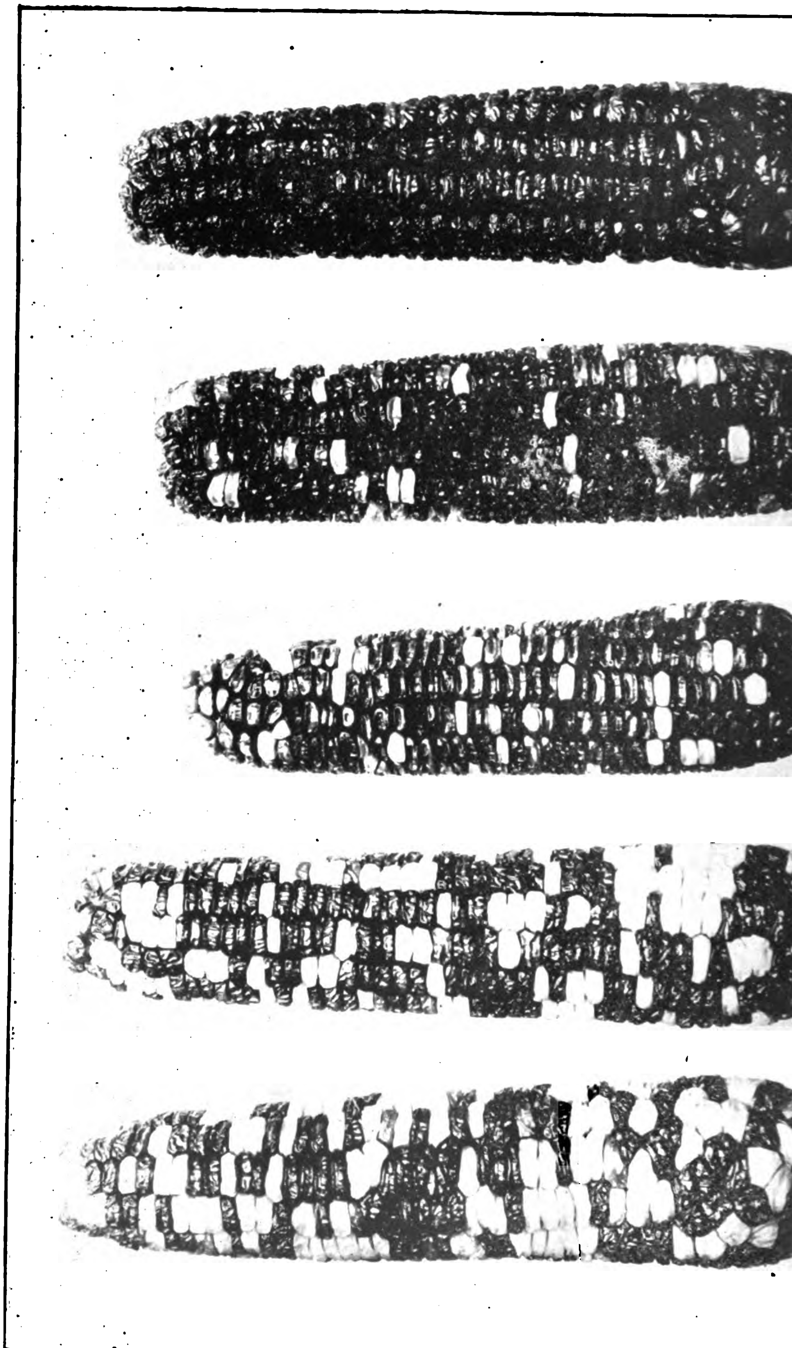


PLATE V.

Upper half is a surface view with section shown below. On the left is the " Long
right, " New York Improved," and the Cross between them in the middle.



ount made the year before for the crop upon the same

	Uncolored.	Black.	Red.
1900)	172	121	92

at the number of red (pink) colored grains has greatly ourse at the expense of the uncolored (white) and dark . There is, however, an increase in the actual number ar of 47—a feature of no small consequence when many ered an advantage in sweet corn.

int to be observed, in a study of the ears as a whole, is iation in them than last season. In 1900 the ears were ke, five of which were shown in a plate in last year's season they range all the way from those with about ins to ears in which the color was entirely red. A rep-up is shown in Figure VI., where the ear upon the left extreme for white grains and the one upon the right The middle ear is as near an average in regard to color ay be selected.

l at the outset that pink grains for seed were selccted more than ten rows of grains. This selection may d the ears, for nearly all of them are more than eight-this respect the "Black Mexican" type is largely lost 'en per cent. of eight-rowed ears are still met with, but n to have no greater percentage of dark grains than

e feature this season is the number of ears that have of grains, namely, the uncolored and a pecular bluish ay be styled "lead-colored." That these ears have darkest pink grains bordering upon purple is almost er plots, where the so-called "black" grains were ermine the power in reproducing their kinds. This bject is considered elsewhere. Some of the ears are or "lead-colored" and white, and others are entirely and white. In short, there are all variations between named, which shows the great power each grain has grains like itself, and this leads one to place great on the selection of just that type of grain that is desired t. If this work of crossing corn had no other output ing of this underlying principle of plant improvement, e fruitless indeed. The results are so rapid and cumu-

lative that every grower should look upon his seed as the fac work, largely under control, that makes for success or failu case may be.

Plot I., Series 0, was devoted wholly to corn for the presen excepting some late-planted squashes and cucumbers. The was pink grains, selected from a dozen well-shaped, eight-ro from Plot IV., Series VI., of the previous year. The ha concluded upon September 27th, and, upon making a close son with that of Plot IV., Series VI., previously reported, no difference to be found in the percentage of the various grains, so that what was there stated holds with equal fo The only difference between the two plots was that of the grains upon the ears used for seed. Excepting this, that now under consideration is a higher piece of land and not plant-food, and while there was not a great difference in size and yield, they were in favor of the Plot IV., Series VI.

The following table shows the types, in rows, for one hun for three plots, where the seed ears varied in number of row

	8-rowed seed.	10-rowed seed.	Ove
No. 8-rowed ears	26	36	
" 10 " "	46	25	
" 12 " "	27	37	
" 14 " "	1	2	
	100	100	

	A
No. 8-rowed ears	
" 10 " "	
" 12 " "	
" 14 " "	

From this it is seen that the greatest number of 8-rowed from 10-rowed seed and the greatest number of 10-rowed from the 8-rowed seed. The greatest percentage of 12-ro was from the 10-rowed seed and the majority of the ears 10 rows was from the ears with 12 to 14 rows. Out of th test one would not get much light upon the method for sele definite type as to number of rows to the ear. This is a f cross-bred corn that is quite different from that in color, for deeply seated than mere color of the grain, that may be influ

While the "Black Mexican" is an 8-rowed variety, the " has no fully-established number over 8, and this vari- l a preponderance of influence upon the rows in the ear, e above indicates, where nearly three-fourths of the ears ore than 8 rows. The same stalk may bear an 8, a 10 wed ear, showing that circumstances determine the num- he same plant, and these may be entirely outside of the n of the cross.

Series 0, was planted again to corn, this time with pink 10-rowed ears. There is little to be added to what has concerning the results upon the two other plots planted r grains. There was quite a uniform increase of the pink that of the previous year, and some ears were found with rains. The fact that grain for 10-rowed ears had no dency to produce 10-rowed ears is mentioned elsewhere form. In this instance there were more 8-rowed and 12- than those that were 10-rowed, like the parent ears. Sev- of similar observations are necessary for the formation of rule that may hold in these cases.

n of Plot I., Series VI., was set with corn started in the The seed did not differ in kind from that used in the mentioned. The corn did not grow for some weeks after the field and made a small growth, but was a week or so in the other plots. The percentages of red grains and of rows to an ear were not different from those elsewhere. no decided gain in anything by thus starting the corn in- etting it out when four weeks old.

With White and Black Grains.

Series IV., was planted to corn on June 28th, purposely id mixing with the plots receiving the pink grains. The as the white and the black grains from ears with over ten nk grains of which had been planted in Plot 2, Series VI. astern rows of the plot were planted with the white grains stern six rows with the black grains. All else was in xcepting that six of the white hills were covered with at blooming time, and these are reported upon elsewhere. no difference in the plants between the two halves of the growing; that is, the size of stalk, time of blooming, f leaf, were uniform.

The harvest was made on September 30th, and an average ear selected from each row. The outermost row planted wi grains showed about twenty per cent. of the dark grains, w outside row, planted with black grains, gave practically th number that were either white or off of the black color. I and seven were adjoining, and upon the row planted wit grains the white predominated, and upon the other row t led. The number of each color was as follows:

	White.	Pink.	Black.
Ear from white seed	330	33	93
Ear from black seed	178	49	193

It is seen that, while the mother plant controls the colo much more evident with the white than the black color. I were made upon the prevailing winds at the time of bloomin might have favored one or the other side. The well-known the readiness with which corn will cross finds a good illust the present instance.

Some of the grains, ranked as pink in the tabulation, are or marked with bars of color; occasionally a half of the grain purple, so that some ears have a wide range of grains, in thi indicating an unsettled condition of things.

A count was made of the best ears throughout the plot, following are the numbers for the various rows upon the cob

	White seed.
No. of 8-rowed ears	15
" 10 " "	42
" 12 " "	58
" 14 " "	4

This shows a very large percentage for the 12-rowed type.

As the seed used in the plot is from the same ears as that IV., Series VI., all being over 10-rowed, a comparison w harvest of that plot may be interesting, for which facts see page.

Inbreeding of the Crossed Corn.

During the present season an attempt has been made to corn. Of the lot of corn transplanted from the greenhouse to 2 and 3 of Plot I., Series VI., five separate hills were thinn single stalk shortly before the time for the tassel to appe

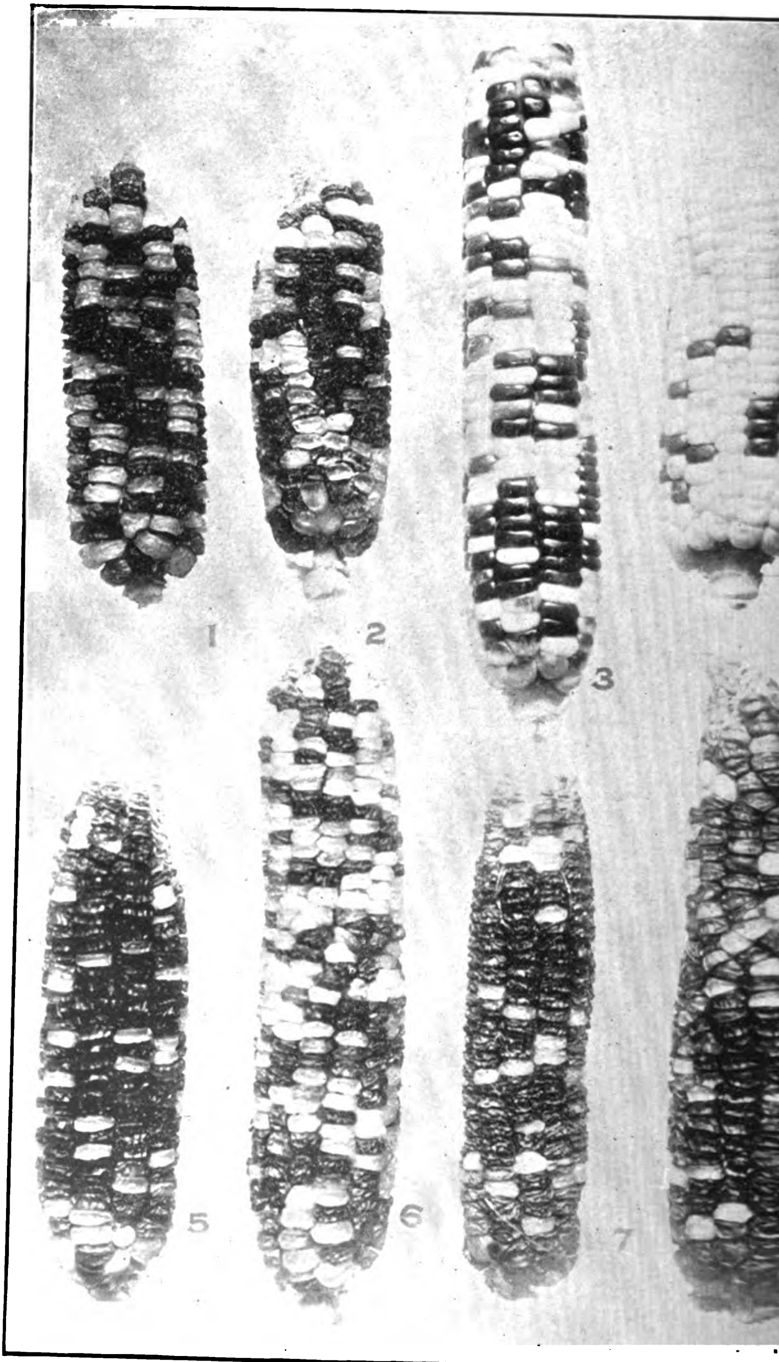


PLATE VII.

Inbred and Wide-bred Corn. The upper row shows inbred ears, Nos. 1 and 2 dry, and Nos.
green. The lower row shows ears from detasselled stalks.

h a "tent" made of cloth tacked to stakes that were he ground. These "tents" were triangular, one foot side, and everywhere made, as it seemed, pollen proof. nclosures the stalks remained for three weeks, the only ven them being an almost daily jarring, to assist in the pollen that of course was shut in from the ordinary winds und them.

served during the time the "tents" were in use that or- ks in the open, comparable in every way with those tured much more rapidly. While it is, for example, a well- ct that the tassel begins to show pollen in its lowermost me two or three days before the silks of the same stalk he confined stalks this period was increased to a week or ys. It was also noted that the silks of the "tented" green and apparently receptive for a time, far exceeding surrounding corn. Last season an experiment was made uration of fresh corn-silk by removing all the tassels from ed late, and therefore in bloom after all surrounding plots gone to seed. It was then demonstrated that silk de- ollen did not only grow to enormous size, but kept green hree times the normal period. The "tented" plants be- e same way as if the pollen did not reach it promptly, probably true because of the confined condition of the treatment. Good ears, however, did finally form in the may be shown by those figured in Plate VII. No. 1 is om the corn started in the greenhouse above located in No. 2 is a similar ear from a plant "tented" in the same ore noted, but in Plot IV., Series VI., where the seed lanted in the field. These ears are both short, but well ith normal grains and with an admixture of white and ll the aspects of the ears of the crop of the previous No. 3 is shown an ear obtained by covering the young blooming, with a paper bag, while the tassel had been eated some days before. When the silk was ready the ing the tassel cut from its stalk replaced the one that had protected the young ear. The latter large bag was kept til the corn had set. There seems to be very little op- f foreign pollination. The ear shown, one of several, is and is from a stalk that grew from a very dark grain. re of grains is more distinctly black with white, not well e engraving, as the photograph of this No. 4 being taken

when the ear was freshly picked and the grains were pl
4 differs from the preceding only in being from a white g
mixed corn, and nearly all the ear is of the same color.

There were seventeen separate stalks placed in "tents
ent dates, and a majority of them produced ears, while ot
probably because a mould attacked the pollen during a
So bad was this upon some stalks that it is a wonder th
formed, The "tents" might be improved by being exte
or more above the tassel and a larger diameter of the w
add needed space.

The conclusion seems to be that inbred corn reproduce
liarities of the stock; that is, a pink grain from a mixe
duces a mixed ear, but at the same time a black grain fro
mixed ear shows an increase in the black and a white g
crease of the white. The immediate parent, while having a
does not control the offspring.

Wide Pollination in Crossed Corn.

As opposed to the tests in inbreeding, at the same time
were placed in "tents," certain others in the same plots
comparable with them were detasseled, and therefore the
of inbreeding destroyed.

Ears Nos. 5, 6, 7 and 8, in Plate VII., are from such cast
from four different plots. In this instance it seems evid
removal of the tassel at a time when it is issuing from its c
is injurious to the plant. With the exception of No. 6,
ears shown are first-class. The cut stalks seemed to br
top and cease growing, and, of course, they lost some lea
the decapitation. None of the ears filled out well and we
in breadth, as is evident in Nos. 7 and 8. All four ears
from the same stock of pink grains and they do not differ
age of pink and white grains from those grown norm
them. No. 6 is somewhat lighter than the average an
three are perhaps a trifle darker, so that a fair average is r

Nothing in this test goes counter to the generally acce
that pollination between different plants is the rule wit
which there is ample provision in the high position of the
great abundance of dust-like pollen and the silks of any g
maturing somewhat later than its own tassel.

Breeding of Corn for Prolificness.

t (in Plot III., Series IV.) was planted late, June 28th, k grains selected from the seven ears taken from three in Plot IV., Series VI., of the previous year. One of re three fine ears and the other four of the seven ears de twins. There were but few triplets in the original he twins were not rare. The triplet had two ears, with rains and one ear with fourteen rows. One of the twins d ten rows to the ear respectively, while the other pair -rowed. Therefore, of the seven ears one was 8-rowed,)-rowed, two 12-rowed and one 14-rowed, or an average s to the ear.

nade a fine growth of stalk, and in size it was entirely n this respect. Owing to late planting the season was it the absence of early frosts favored the experiment, and harvested upon October 13th, at which time the grains had begun to shrivel.

six rows of eight hills each, or 48 hills, carrying 144 ng the many "suckers," some of which grew tall and all ears not considered in the count. There were 44 ingle ears, these being unusually large and invariably nore rows of grains. Eighty-three stalks had two large, ars, with rarely less than ten rows, and one was a pair of s. There were 17 with three or more ears, among these lk with five ears, all over five inches long, and one with her with seven ears, but of these only one or two were The tendency to produce ears had thwarted the end d formed, which were not at all desirable.

f the number of rows to an ear for seven sets of triplets :

	Stalk 1.	Stalk 2.	Stalk 3.	Stalk 4.	Stalk 5.	Stalk 6.	Stalk 7.	Total rows.
r..........	8	12	8	10	10	12	8	68
ar.........	12	8	10	10	10	12	10	72
r..........	12	8	12	10	8	12	8	70

that the average number of rows does not vary much ion upon the stalk. The upper ear may have the small-f rows, as in No. 1, or the largest, as in No. 2. The be the same for all the ears, as in Nos. 4 and 5, or the ay have the largest number, as in No. 7. The average he twenty-one ears tabulated is exactly 10, which is one that in the lot of seven ears that furnished the seed for

the planting. This is true, however, that the ears borne s lot gave a higher average than the triplets above tabula same is true of the pairs of ears, so that the average of th rows is brought up to fully that of the seed ears, and the shows clearly that the grains from ears with many rows ency to produce ears similar to those furnishing the seed

This is only an incidental fact, and the still more imp the exhibition of the tendency to ear formation. This i evident when it is stated that upon all the other plots o 432 hills, not a single triplet was found, and comparative In order to get the required amount of the ears desire to use twin ears was possible. It is regretted that th twins was not recorded, but, as stated, they were not co the other hand, in the half plot in question, where two triplet were used for seed, the number of ears was 272, average of two ears to the stalk, exclusive of many "su sometimes eared at the tip in a cluster of grain-bearing s

FURTHER OBSERVATIONS UPON SALSIFY H

In the report for last year (pages 445–447) the resul time are given upon the work in the crossing common ga or "oyster plant," *Tragopogon porrifolius* L., with the *T. pratensis* L. The hybrid plants, twelve in all, seede and these seeds were sown in Plot I., Series VI; but owi favorable dry weather the autumn growth was not as i otherwise been. The seeds from each hybrid plant w separate rows, that any differences in the offspring migh

The two parent species, while agreeing closely in man strikingly different in the color of the flowers, those of t salsify being light violet red violet*, while that of the is deep yellow.

It is seen, therefore, that in one parent the floral colo ture of violet and red, the violet predominating, while t simple yellow. There are two types of the crossed plan the color of the inflorescences, namely, (1) with both the central flowers all colored alike, darker red, red vi those with only the ray flowers, the above color, while central flowers are yellow, excepting possibly the tops o corollas; in short, the central flowers closely agree with male parent. This second type favors the wild species,

* In this record, Prang's color chart is employed.

hes the cultivated form. There were no intermediates two above types. It is seen that in the crosses the violet ned, while the red has greatly increased and the yellow evidence in one of the types.

arge numbers from these hybrid seeds have been observed and the range in colors is a wide one, no less than thirty- in Prang's list being present.

ith the red end of the spectrum, the number of blooms two different dates (June 1st and 8th) follows the name color matched with the flowers.

Color.	Abbreviation.	June 1.	June 8.	Total.
arker red	(R-dd)	7	16	23
ark red	(R-d)	7	6	13
ark red red orange	(RRO-d	1	...	1
arker red orange	(RO-dd)	4	2	6
arker orange red orange	(ORO-dd	6	3	9
ark yellow yellow orange	(YYO-d	1	...	1
ellow yellow orange	(YYO)	1	...	1
ark yellow	(Y-d)	1	1	2
ellow	(Y)	5	5	10
ght yellow	(Y-l)	6	6	12
ghter yellow	(Y-ll)	2	4	6
arker yellow yellow green	(YYG-dd)	1	...	1
ark violet	(V-d)	1	...	1
iolet	(V)	3	...	3
ght violet	(V-L)	2	...	2
ghter violet	(V-Ll)	1	...	1
ark violet red violet	(VRV-d)	...	...	...
iolet red violet	(VRV)	13	10	23
ght violet red violet	(VRV-L)	23	12	35
ghter violet red violet	(VRV-Ll)	14	15	29
ark red violet	(RV-d)	1	1	2
ed violet		3	2	5
ght red violet		4	5	9
ghter red violet		...	...	...
arker red red violet		3	...	3
ark red red violet		1	2	3
ed red violet		1	1	2
ark orange gray		1	2	3
ange gray or brown		3	...	3
arker red gray		1	...	1
ed gray or russet		3	...	3
ght yellow gray		1	...	1
ghter blue gray		1	...	1
ark violet gray		6	...	6
ight violet gray		1	...	1

It is seen that the color of the *T. porrifolius* has the larg with its nearest neighboring shades as next largest. Th follow closely. In short, the violets and reds predom in the yellow there is a fair showing.

During the present season the seedlings of no one n differed in any particular way from others. They all sho the wide variation in the colors of the flowers that has b in the table.

The piece of ground bearing the hybrids is left with t self-seed the land, that a study may be made of the persis forms when growing, as nearly as possible, in a state of n

Whether a drifting back to one or the other, or both take place, or instead, a new hybrid species will come int is one of those questions that is not answered by philoso the action of the surrounding influences, in combinatio internal forces upon a confused and interblended str currents.

Plot II., Series III., was sown to salsify, the seed in al being from the plot where hybrids occurred the previous natural mixing was to be expected. There were but among all these suspects that proved to be hybrids, and invariably in the rows with the cultivated species. The similar to those of 1900, were of two types, previously de were large in size and enormous bloomers. The seeds of were sown in mid-summer for a second plot of seedling h have made a good stand for passing the winter.

A large amount of artificial crossing was done with the two parent species, that the stock of the hybrid may be so f next year that the roots may be tested as to their merit of food.*

Other Crossing.

Two species of Martynia have been grown the present the purpose of hybridizing. Several fruits were obtain *Martynia Louisiana* Mill. and *M. lutea*, with the former as plant; but the three fruits upon the latter parent were when the frosts came to give viable seeds. What this u

*Some of the above facts were given by the writer in a paper befo American Association for the Advancement of Science, at its meeti Colo., in August.

species may produce is a matter for the future, but eptable pickle may result.

ots were made to cross the trumpet creeper (*Tecoma* pon the Martynia, but without success. While closely many peculiarities the same, one is a hardy vine and der herb, a combination of which characteristics one secure.

together of the ordinary field flax (*Linum usitatissimum* amental species *L., grandiflorum L.* (?), has been at- several full-sized seed vessels were secured upon the they all but one proved to be seedless. In this in- species are widely separated in this, that the blue flax all its sex organs alike; but in the scarlet species of re are two lengths of the female organs. Plants with s developed are combined with difficulty with other said that plants of one form of pistils are sterile to and need the pollen of the other form of flower for If this is the case it only heightens one's desire to if it is a possible thing.

BREEDING AND IMPROVEMENT IN OUR EXPERIMENT STATIONS.

g is an abstract of a paper read at New Haven, Conn., , 1900:*

of inquiry was sent to each Experiment Station, and tations now on the official list reports were received abama, Arizona, Arkansas, California, Colorado, Con- Haven and Storrs), Florida, Georgia, Illinois, Indiana, Kentucky, Lousiana, Maine, Maryland, Massachusetts, sissippi, Missouri, Nebraska, New Jersey, New Mexico, eva), New York (Cornell), North Carolina, Oklahoma, lvania, Rhode Island, South Carolina, South Dakota, shington, Wisconsin, Wyoming.

Experiment Station responses are taken up alpha- ng those reporting no work in plant breeding and

ulletin 56, May, 1894, is upon "Crossing for the Pur- ing the Cotton Fibre;" Bulletin 71, April, 1896, is

* annual convention of the Association of American Agricultural riment Stations.

"Experiments with Foreign Cottons," and Bulletin 83, J
has for its title "Hybrids from American and Foreign
"The combination of the *Gossypium hirsutum* and *Gossypi*
mum yields a cotton plant which produces fibre of the bes
strength, maturity, twist, length, fineness and yield per acre

California.—"In answer, etc., * * * for our work in th
tion of new varieties by crossing, etc., we can only confes
done nothing, nor have we published anything on the sub
Burbank, Judge Logan and Mr. C. P. Taft, of Orange; M
herd, of Ventura, and others, have undertaken much in th
you know, and because of the activity of private propa
have given very little attention to the subject."

Connecticut.—Mr. J. B. Olcott, of Connecticut, was at
strongly advocating the improvement of lawns by a metho
cuttings, thus producing a uniform turf of the same strai

Georgia.—"Some years ago we did a good deal of work i
varieties of cotton."

Illinois.—Bulletin No. 21 gives the results of Mr. McClu
crossing of corn, and Bulletins Nos. 53 and 55 report th
Professor Hipkins in selection with reference to the chemic
sition of corn. Considerable work has been done upon inb
corn. Three generations of inbreeding results in almost st
first generation showing a degree of unproductiveness t
practically amount to the ruin of a crop. So pronounced is
of even the first generation from inbreeding that we are led
if this is not the practical cause of barren stalks, which in th
amount ofttimes to 20 per cent. of the crop.

The results of Mr. McClure's work are briefly summari
lows: "In 1889 sixteen crosses in corn were produced; in
hundred and fifty-eight." Among other things the results
"that corn grown from crossing two distinct varieties will
than the average of the kinds crossed, or when the parents
equal larger than either."

Indiana.—For many years we have grown with much car
of yellow dent corn, which is known as "Purdue yellow d

Iowa.—Bulletin 14, August, 1891, is upon "Breedi
Orchard and Garden Fruits," in which notes upon seedli
of apples are recorded. Bulletin 22 (1893) contains a sec
"Rosa Hybrids," which were of the Russian type of *R*
as the pistillate parent with "General Jacqeminot," "
Beauty," and other standard roses, the hope being a dou

airie region. In Bulletin 32 (1896), Professors Budd report upon "Some of Our Advances in Breeding rubs," and figure new hybrid roses of great promise. erries, grapes, plums, pears, apples, are also considered. (1897), under "Hybrid roses, gooseberries and strawssor Budd shows still further advances, and an engravy-fruited hybrid between a wild gooseberry of Mani-Champion."

fessor Kellerman, assisted by Mr. Swingle, began the ld corn at the Kansas Station in 1888. From the next year, 1889, the following: "The effect of crossys be plainly seen the second year, whether visible the t. The crosses * * * were generally of two types: which the kernels were uniform, and (2) those in re variable." From Bulletin 17, December, 1890, it t "The product of the third year is generally true to d." Forty-nine crosses of 1890 were planted in 1891, 3 harvested, 25 showed intermediate characteristics parents. The bulletin concludes with the following The characters secured by crossing can be retained."

From Bulletin 26, February, 1894, it is gathered that lier, "Some stalks of cane, partly white and partly lected from the field of Soniat Brothers' Tchoupitoulas hey were called by them bastard canes. These stalks s follows: First row, the entire stalk; second row, s of each stalk; third row, the colored joints of each end of the season, four distinct canes, as far as color s, were obtained." By selection, the varieties have received names and "are different from any other in ."

s gathered from the reports of 1893, 1894 and 1896 k has been done in improving tomatoes, and particu- species hybrid between the ordinary form (*Lycoper-* Miller) and the current tomato (*L. pimpinellifolium* ter bearing small fruits in racemes like currants. By two species, the "Lorillard," a standard forcing ssed with the current, and selecting and furthermore rid with the "Lorillard" again, the fruit has been an acceptable market size and the quantity much

Maryland.—Considerable work is in progress along l in both the Horticultural and Agricultural Divisions, has been printed.

Massachusetts.—They have hundreds of seedling straw ling raspberries, some of which show great merit, and s berries, some of which are of great promise. A lot of s not tested in California have been sent to them by Lu for trial and distribution, the entire stock being in thei

Michigan.—From the bulletins and reports it is ga large amount of work is done at the central and sub the trial of varieties of fruit and vegetables and their through selection. In the earlier days of the Agricu some crossing and hybridizing was accomplished, in particular, by Professor Bailey, before he went to Corne

Minnesota.—Bulletin 62 has been received upon " ties Breeding, Cultivation." Professor Hay, the auth the leading breeders of cereals on this continent, with nificance along his line in Dr. Wm. Saunders, of the Farms, Ottawa, Canada. As early as 1889 Professor H from the Minnesota Station, bulletin 7, upon "Impro Cross-fertilization and Selection," The following facts a the summary of the bulletin recently issued: "Hybrid in yield, in grade or quality, in rust resistance. * * matic selection of * * * hybridized wheats, impr are originated at slight cost. * * * Three out o ties, first originated by selection, are being disseminat new hybrids are very promising."

Mississippi.—Did considerable work in crossing "Egyptian" varieties of cotton with our native sorts.

Missouri.—Here they have two varieties of seedling st yet named—promise to have much commercial value. working on radishes and plums.

Nebraska.—The Professor of Horticulture kindly refe thirteenth annual report, where it was found that "Wo in improving the sand cherry by selection, * * * zation with cultivated plums and cherries. The wild ing treated in much the same way." The wild black wild grape are being considered, and the hybridization of watermelons are going forward, while a co-operativ in corn breeding with Dr. Webber, Chief of Section of ing of the United States Department of Agriculture, is w

ne work noted in the report referred to, by letter it is his division has recently begun an important piece of e line of the production of new varieties of apples by ridization.

—Some work is being done in the breeding of truck ılarly beans, eggplants, tomatoes and sweet cqrn. et ready for distribution. A hybrid has been secured pecies of salsify, that shows great vigor and may prove he white mould than the old garden form.

.—"In the earlier part of the history of the Station an nade of originating varieties of wheat by crossing. In lination was performed with the 'Wolf' and 'Yellow

Geneva).—"This Station has given more or less atten- mprovement by crossing, etc., since 1883. About that odd originated the 'Station' pea, which is regularly e seedsmen, and the 'Station' tomato. Since 1893 strawberries has been continued till the present. Only s been disseminated for trial, viz., the 'Hunn.' Par- is given to the improvement of grapes and in fixing cters. This work is fundamental and preliminary to dvance in the improvement of this fruit. Some atten- apples and pears, also gooseberries and currants. At 89 the inventory showed the following Station seedlings Apples, 81; pears, 39; apricots, 5; cherry, 1; peach, ; grape, 636; currants, 53; gooseberries, 680; black es, 182; raspberries, 958; strawberries, 429; total, is list were added, in 1900, apples, 65; pears, 35, and er 3,000 grapes. A few were discarded, but the present ation seedlings under test is more than 6,000. Many ast years have been discarded.

who, of all others, has been the leader in point of time f work in the breeding of corn is the late lamented Dr. int, who, as early as 1883, in the second report of the eneva) Experiment Station, recorded much study of, e with, the crossing of corn. Each annual report for contained details of the hybrid corns, with observations e."

Cornell).—In the horticultural department they have xtensive studies, for many years, of plant-breeding, but se of arriving at the principles which underlie the

subject rather than producing new varieties. Only one con variety have we sent out, and that is the "Ignotum" t rather full history of which you will find in the latter part of "Survival of the Unlike," and also in "Plant-Breeding.' have produced at least one thousand varieties of pumpk squashes, none of which, however, were of sufficient comme portance to be introduced. They have made great numbers o with flowers, fruits and other things, but not for the purpose nating varieties which could not be propagated and name original desire was to make varieties of fruits and vegetable soon changed for the more important one of arriving at p first, as there seems to be a lack of comprehension of this su the public mind.

North Carolina.—The principal success heretofore has the growing of a great variety of colors of the popular generally known as "Crape Myrtle." They are also working getting a tomato more resistant to the Southern bacterial starting with the little cherry and plum sorts that are t resistant. They have also a new eggplant, that seems res this blight. In the way of garden vegetables they are at wor to produce a lettuce that will suit the winter gardeners bet any they now have.

Oregon.—The work has been undertaken along the line and flowers only. They have a very promising pear, that wa several years ago with the "Winter Nelis" and "Bartlett tree has borne fruit this year, and has the qualities of the two They have fifteen crosses of roses and a number of good cr the pelargonium.

Rhode Island.—In the horticultural department strawber beans have been experimented with. The selection of bu is also underway here. The agricultural division is investiga peculiar characteristics of the corn-plant, and will endeavor mine, if possible, what characteristics of the stalk, leaves, correlated with the best yield of seed. An attempt is being establish a standard for the corn-plant, at least of two variet to breed to it for improvement. Similar work is being ca in studying the characteristics and seeking to improve the y several varieties of timothy, wheat and rye. An attempt being made to secure, by selection and breeding, strains of varieties of soja beans and cow peas in the endeavor to secur

e especially adapted to the soil and climatic conditions and.

lina.—The only work in the lines mentioned has conducing new varieties of cotton from artificial cross-breedl by hybridizing the *Gossypium Barbadense* and *G. her-* both lines they have succeeded in producing cotton ither parent.

ota.—Several hundred crosses were effected this year, ng outlined as follows: (*a*) Crossing of several Russian fe and blue stems; (*b*) selections from both the blue e fifes; (*c*) the crossing of spelt and barley and spelt eat; (*d*) selections from spelts, oats, barley and corn; sing of the two best varieties of field peas; (*f*) the our two most promising varieties of corn; (*g*) work en begun on clover, Turkestan alfalfa, about twenty asses and the species of salt bush.

of work in the Horticultural Department may be sumfollows: 1. The breeding of native fruits by selection g. 2. The breeding of apples and plums. 3. The an extra early smooth tomato by crossing and selection. ocks for the orchard fruits. 5. Cultural and variety etables and fruits. 6. Hardy hedge and ornamental Forestry and tree-plants.

n.—They have begun the improvements of wheat, both and by selection, and are attempting to produce winter will stand if on rich soil, will not shatter out with handhite grain, no beards, yield well, and resist bunt. In ey are working with two distinct objects in view; the mprove standard varieties; the second is to determine f continued selection in any given direction. For the cters are chosen that easily show the effect of selection are effects, such as breeding beards upon bald wheat, *a;* breeding rufus chaff from white, etc.

—They have been at work for several years past in seekove the varieties of the native plum, the apple, the Mist (*Ribes aureum*) and the dwarf Rocky Mountain cherry *eyii*). They have also commenced some work with wild (*Prunus serotina*). They are doing this work chiefly by dlings. In the apple they have planted selected varieties d place, with the express intention of planting the seeds fruits that grow on the trees. In the native plum they

are planting seeds from trees that are located to favor cros
tion. In the wild black cherry they have started with the
variety that they have been able to find, and hope to sec
large enough to have commercial value.

In the above digest of the results of our Experiment S
plant-breeding it has not been the intention to include all
done along the above line in the United States. Much
accomplished by persons who were not associated with E
Stations and Agricultural Colleges, and, in fact, did their
before these institutions came into existence. In this conn
first recalls the development of our American grapes and th
into them of the European blood, and call to mind the nam
Rogers, Haskell, Ricketts and Moore, of the East, while
Jaeger and Munson have labored faithfully in the Southwes
and others have already made America famous for its lo
varieties of superior cross-bred grapes.

Among pears we have blended the blood of the commo
Chinese species, and obtained varieties that have made pea
possible, if not very profitable, over a wide region where it
carious before. The names of Keiffer and Leconte will be
with these excellent results in hybridization.

The fact that the ordinary varieties of Eastern apples
hardy in the great, cold Northwest, early led to importa
Russia, and the crossing of the common species with the
Crab, the good results of which are still in store for the peo
twentieth century. For similar reasons the native plums in
and South have been placed under culture and bred with the
types. Along with this is the advent of the Japanese plum
formation of a group of hybrids, that places the name of Lu
bank among the word's great horticultural benefactors.

Less distinct from the Experiment Stations than many of
breeding enterprises included in the above general rema
work upon the citrus fruits by Messrs. Webber and Swing
United States Department of Agriculture. The "Florid
from which catastrophe the orange growers now date al
events, aroused the government to the point of seeking f
hardy orange, and the hybridizers are well on their way to p

Space does not permit of more than a passing allusion to
dreds of florists who are constantly keeping American flori
the van, particularly as to new crosses of carnations, chrysan
and roses.

t few remarks I am indebted, in part, to the excellent ridization in the United States," by Professor Bailey, in ssued report of the Hybrid Conference, held at Chesidon, in July of last year, at which Professors Webber, Hays took part, and besides, Professor Bailey, Dr. MacMr. Thomas Meehan sent papers. In this world's con- 'a world-wide subject, the United States took its full ors.

ains for the Experiment Stations to follow up the work a, and remember that he who improves the plants of a oves its products and its people.

XPERIMENTS WITH SALAD PLANTS.

d was grown in belts 4, 5 and 6, Plot IV., Series V., May 13th), while two belts elsewhere (Plot II., Series n late (July 28th). Both sowings grew well and furundance of the leaf stalks. The early lot was somewhat the leaf blight (*Cercospora beticola* Sacc.), while that s nearly free. This verifies the results of former years, ht does not flourish upon the late-grown plants, and sh an abundance of a wholesome pod herb can obtain it Chard when the seed is sown in ordinary soil as late as gust. Some plants that had been removed to the greenimn, and after furnishing leaf stalks through the winter, ken to the field, where they made a fine early growth. ows that the Swiss Chard is easily handled, and when rtunity for continuing the growth indoors it can furnish eens during winter.

npts were made to test this salad in the city market and ble success. Nearly all who used it were desirous of

d Spinach.—A few plants of New Zealand spinach were ne greenhouse to the trial grounds in early spring; elseas sown at the same time. The plants thrived and furghout the hottest weather an abundance of tender leaves tems. While the plants from the greenhouse covered pidly, those from seeds were fully as large in September. excellent salad plant, that is worthy of attention by every rden and a fondness for greens throughout the season. Two varieties were grown in small quantity and both nade fine plants. It transplants readily, and the field- may be treated as above mentioned for the chard.

EXPERIMENTS WITH WEEDS.

The piece of ground, 11 by 33 feet, called "the weed been continued for the fifth season. Plants have grown w their seeds and scattered them as in a wild state. The the list of fourteen species most prominent during the ye

1. *Rumex acetosella* L. (0), (7), (4), (1).
2. *Bromus racemosus* L.
3. *Abutilon Abutilon* L. (7), (2), (6).
4. *Polygonum Pennsylvanicum* L. (6), (3), (2).
5. *Daucus Carota* L. (12), (0), (0), (4).
6. *Chrysanthemum Leucanthemum* L. (0), (0), (0), (9).
7. *Silene noctiflora* L. (9), (13), (14), (7).
8. *Taraxacum Taraxacum* L. (0), (0), (9), (5).
9. *Convolvulus arvensis* L.
10. *Melilotus alba* L. (0), (0), (0), (12).
11. *Oxalis stricta* L. (0), (0), (0), (8).
12. *Plantago lanceolata* L. (0), (0), (11), (10).
13. *Rudbeckia hirta* L.
14. *Ambrosia artemisæfolia* L. (3), (5), (1), (1).

It is seen that there are three new species upon the list eleven old ones many have changed places. A brome-gr bindweed and yellow daisy are the ones that have come front, while the ragweed, for example, has dropped fro to the foot of the list. The smartweed, velvet leaf, wild catchfly are all near their places for 1900.

There are many competitors not in the above list, amon following are mentioned :

Three kinds of clover—white, alsike and red ; five kin —timothy, foxtail, redtop, a poa and a fescue ; doc goose-foot, four asters, burdock, flea bane, salsify bot and wild, broad plantain, asparagus, tomato, young gra small cherry tree.

One of the things observed is the tendency for the groun covered with a growth of low plants, as the clovers and bindweed ; along with this there is a formation of a sec foliage, represented by the sweet clover, yellow daisy, ve smartweed. Above this will be the cherry tree and the providing the latter reaches the tree, as it is very likely to

[E]XPERIMENTS WITH LAWN GRASSES.

[P]lots of grass selected in the spring of 1896 have been [cu]t with lawn mower during each season, and notes made [from t]ime upon the condition of each plot. The following [gives th]e species of seed sown in each plot and the condition [o]f grass, in percentage, for the past six years :

	1896.	1897.	1898.	1899.	1900.	1901.
[F]escue (*Festuca pratensis* Huds.)....	90	50	40	45	55	60
[...]ed Fescue (*Festuca tenuifolia* Sib.)..	5	50	40	40	40	45
[F]escue (*Festuca ovina* L.)..	10	50	40	40	30	25
[Is]land Bent (*Agrostis canina* L)	80	80	90	90	90	95
[M]eadow (*Poa nemoralis* L.)............	60	65	70	85	80	85
Blue (*Poa pratensis* L.).............	50	65	90	90	85	85
[M]eadow (*Poa trivalis* L.)................	80	65	70	70	45	70
[A]*grostis alba vulgaris* With.)	100	90	70	60	25	25
Rye (*Lolium perenne* L.)......	100	85	70	40	20	15

[...]hat the "Rhode Island Bent" holds up well, and the [a]utumn, at time of last inspection, was approaching [...]n the dry weeks of summer it becomes brown, and for [...] present rating may be high. It is exceptionally fine in [...] "Kentucky Blue Grass" has proved very satisfactory [...]hree years, but some weeds have crept in the present [...]e "Wood Meadow" plot the grass has held its third [...] seasons. The "Meadow Fescue" has made a gain [...]n over the previous year, and, being at one end of the [...]s favored by a border gutter along one side of the plot. [...]" shows a poor stand and the "Perennial Rye [...]rly gone out. The leading weed in autumn is the crab [...]s in all vacancies.

[EXPE]RIMENTS WITH ORNAMENTAL PLANTS.

[...]g ornamental plants were grown this year, several for [...]essive season :

[...]*um.*—A type of hardy chrysanthemum has been grown [...]nent Area for several years and uniformly free from the [...] *Hieracii* Mart.), that has been so destructive to the [...]rysanthemums. Last year it was stated in the annual [...]. Kelsey found the rust upon some plants in a florist's [...] present season a plant of this affected sort was set in

the midst of the chrysanthemums in our Experiment A
result that the rust is now to be found upon the plants
have been free from the disease. That this is the sa
rust now so troublesome indoors is still a question, and
stage of the fungus is found its exact species is no
Last year some of the original plants were removed to a
a mile away, and these remained free from the disease.

Pæonias.—The plants are gradually increasing in si
summer weather injures the foliage somewhat; other
fine.

Japanese Redbud.—Some of the trees have died, the
too severe for them. The foliage is too tender for ou
summer weather. A cross with the native species is in
come the weakness and yet preserve the good qualitie
tree, that blooms so handsomely in early spring.

Hibiscus.—Much thinning out of the plants was requir
Some of the crosses made previously were in bloom.

Cannas.—The row of cannas added a brilliant displa
mental portion of the Experiment Area. Several seed
special worth, came into bloom.

Nasturtiums.—Only the large form was grown this s
before, showed the scorching of foliage mentioned in pre
Shading on the hottest days is a great advantage.

Mignonette.—Several forms of this were grown w
amount of the leaf spot.

Petunias.—A few plants of petunias were grown and ga
of blooms throughout the season, with no showing o
disease.

Verbenas.—In connection with a study of a milde
verbenas were kept among the ornamental plants. Th
their good name for abundant flowers during the autum

EXPERIMENTS WITH PHLOXES AND THEIR

Belts 4, 5 and 6, of both Plots II. and III., of Series V
pied with several kinds of plants, all of the natural fa
moniaceæ, of which the garden phlox is a prominent m
following plan shows the arrangement of the plants, p
running the short way of the belts; that is, the rows w
long.

HALF PLOT II.—*Phlox Drummondii* and *Cobœa.*

	No.	Belt 5.	No.	Belt 6.
.	10	Kermesia.		Cobæa scandens blue.
ropurpurea.	11	Rodowitzii.		" macrostemma.
. stricta.	12	Cuspidata.		" scandens alba.
	13	Kermesia splendens.	19	Coccinea.
	14	Occulta alba.	20	Black warrior.
	15	Alba.	21	Stellata splendins.
	16	Mixed.	22	Mixed.
ouquet.	17	Half-dwarf blood red.	23	Dwarf snow ball.
se.	18	Fancy mixed.	24	Fire ball.

s interrupted the list of phloxes because desirable to
nk-growing vines requiring a trellis, at one corner.
es failed in no instance to make a good stand, bloomed
n general were probably true to the varietal names.
ber 20th the following notes were made :
ed that as the plants get older there is tendency to vary
mal form. The most conspicuous variation was the
tic) form, met with in nearly every row. These plants
er clusters with the bracts much prolonged and oval-
corollas are with long tubes and the lobes not fully
ving a half-opened appearance to the bloom.
these greenish clusters show that many of them carry
unt of the color, characteristic of the variety. Among
ts the green flowers are present, usually a whole plant
c when any part has green flowers. With red flowers,
the "green" plants bear flowers that are with the red
e mid-rib of the corolla lobe; that is, a single stripe.
are flowers in a cluster, usually there are no two alike.
the tendency to produce green flowers, there was a varia-
several plants. The usual change was shown in a loss
color in one or more blooms, while others in the same
d a deeper color than the ordinary. This was as if the
whole cluster had been unevenly distributed, and where
other had an excess. Such clusters were marked espe-
ng seed.
are particular favorites of certain butterflies, and
insects the Papillios are the favorite attendants. The
the corolla excludes all the smaller insects and those
bosces.
ion of bloom upon these plants has been something

astonishing, especially in view of the fact that no cuttin made, and seed was found all through the season. supply of blooms in great variety of colors, varying shades from white to a dark red, the *Phlox Drummo* accredited with a high rank. These plants could sc give satisfaction when making a bed of solid color or in ribbons, as taste or circumstances may dictate.

The star form (*cuspidata*) was grown in limited am poses of crossing, and it proved wonderfully variable, dozen plants no two were alike in size, shape and blooms. It is sufficiently peculiar as to merit a breeding grounds, but the colors need fixing, and much to improve this strain of phlox.

Half Plot III.—Various Polemoniaceæ.

In this area three genera of closely-related plants together for purposes of study and breeding. The fol arrangement of the species, the rows running across the the annuals given above :

Belt 4.	Belt 5.	Belt 6
Gilia tricolor.	Gilia capitata (blue).	Gilia nivalis.
Gilia achillæfolia alba.	Gilia achillæfolia rosea.	Gilia laciniata
Phlox subulata var alba.	Phlox maculata.	Gilia achillæfo
Phlox pilosa.	Phlox paniculata.	Polemonium g
Phlox divaricata.	Phlox Himalayense.	Polemonium c
Phlox subulata var frondosa.	Polemonium cæruleum.	Polemonium r

As these are set for continuous tests in crossing, little upon the group for the first season. The polemoniu bloomers, while the phloxes and gilias, especially some are continuously in flower from early summer until the

EXPERIMENTS WITH SPRAYING.

The spraying with fungicides this season has been li entirely to soda-bordeaux, with the same formula as in p and it was used only upon a small portion of the crops

Tomatoes.—The middle belt of "stock" tomatoes, Pl III., received four applications of soda-bordeaux on dates : July 20th, 29th ; August 8th and 27th.

The blight (*Septoria Lycopersicæ* Speg.) was the c

ved this season, and as the plants were but lightly in-
was but little difference observed in favor of the sprayed

e crossed tomatoes the leaf spot developed to a much
t, many plants being nearly defoliated before the end of
There was almost no fruit rot the present season.

elt 5 (2 rows), Plot IV., Series V., was sprayed four
soda-bordeaux upon the following dates: July 20th,
t 8th and 27th. Considerable leaf spot (*Cercospora beticola*
eveloped upon the sprayed rows by August 27th, but to
extent than upon the unsprayed. The foliage of all was
by hail early in July.

f all plants were removed about September 1st, and the
rowth suffered much less from blight.

-Several three year-old horse-chestnut trees, alternating
ed ones, were sprayed with soda-bordeaux on June 17th,
29th; August 8th and 27th. The contrast between the
nd sprayed plants was very decided, the former being
defoliated before the end of the season. Like results
d in 1900.

The middle third of the arbor at the farm-house received
ions upon the following dates: June 8th, 17th, 28th;
d 29th. Ordinary bordeaux was used for the first spray-
deaux for the remainder. The mildew was practically
the entire arbor. The sprayed foliage was seriously
e fungicide.

Kerosene Emulsion.

f cucumbers and one of chard were sprayed three times
e emulsion of half the standard strength—that is one
ry soap, two pints of kerosene to eight gallons of water.
checking of the blights and the plants remained un-
e emulsion.

of the verbenas in the ornamental grounds were sprayed
e emulsion for the mildew upon August 1st, 8th and
conditions were highly favorable for the fungus during
of the month, and mildewed leaves were numerous at
g of the experiment. After two sprayings the treated
ess affected than elsewhere and had a glossy appearance,
ue to the emulsion. From the latter part of August to

the end of the season the mildew developed but little up
the plants.

One side of a lilac bush was treated with the emulsion A
and September 10th, without seeming to check the devel
the mildew. In this case the mildew was well developed
foliage, and the two applications did not materially c
appearance of the leaves.

Three places in a large piazza plant of Matrimony vine we
twice each week with the emulsion, and it seemed to p
appearance of the mildew upon the younger leaves, and th
patches upon the old ones were darkened and ceased to fo

Soda-Bordeaux and Paris Green.

To determine whether Paris green may be safely used
bordeaux, the combination was applied to the followi
Potatoes, eggplants, squashes, cucumbers and beans.

Each of the above were treated three times, at intervals
and without harmful results, although the Paris green w
the rate of one pound to 100 gallons, a much higher perce
is commonly employed.

THE ASPARAGUS RUST.

During the present season it was not convenient to ca
experiments with the asparagus rust, and only observati
field and reports from the various Experiment Stations t
the United States are given. The rapidity with which t
has spread has added to the importance of a record of i
range.

Without reproducing the replies to the letter of inquiry
September, the following extracts will show something o
range of the rust and also some points as to its relative
with that of last year.

From New England, where the asparagus is widesprea
erally grown only in limited quantities, the reports show t
less rust this season. For example, in Professor Jones'
Vermont, it is stated that "there has been less of the aspa
in this State than there was two years or so ago."

For Massachusetts, Professor Stone writes: "The rust
prominent here this season and there has been a slight te

* * * My theory has been that drouth causes the
ecome weakened, and hence followed by an outbreak of

laware, Professor Chester sends the following: "During
years it has not been as general and destructive as in the
ng years, but all in all it is general throughout the State."
Norton reports from Maryland that in some places the
dant.

Buckhout writes from Pennsylvania that "the asparagus
ce this year—much less than before." From the South
tes the replies are to the effect that the rust is not in evi-
rom Texas, Professor Price writes, "I have found the rust
the first time this year. * * * The first part of the
was normal and the latter very dry, and the disease is
ng. Judging from its first appearance here this year it
likely that it will prove serious in the State."

Middle States the reports are favorable. Professor Selby,
ites that "there appears to be no spreading of the rust."
gan, Professor Wheeler sends word that "the rust, so far
urn, is not on the increase." Professor Goff writes from
hat "a single case of asparagus rust has been reported
season. * * * This is the first * * * to my
of the disease in our State." From Indiana, Professor
rts the rust as abundant as last season, and "that the
this region in general came this year largely or wholly
blown from considerable distances."

Burrell reports for Illinois that "the disease has been
nd is now known in at least a dozen plantations through-
. * * * This last year seems to have been a bad one
lopment of the parasite. Some beds that were known to
have apparently not shown it at all or to a very slight
am inclined to think that the very dry weather through-
d August had something to do with this state of things."
a, Professor Pammel writes that "I think the rust is on
; at least in this vicinity, but I have not been in corre-
* * * with reference to its general distribution in the

ska, Mr. John Sheldon has made a special study of the
rough Professor Bessey, of the Experiment Station, he
llows: "From observations made near Lincoln and the
have come in, there seems to be much less asparagus rust

than last year at this time. Much of the brush that gre part of the season was badly rusted, but the continued weather of the summer helped to check it on a few s that showed rust now. A few Æcidia showed on them season, but not in sufficient number to bring about gener

To the northward in South Dakota, Professor Saun "I cannot find as it is spreading. * * * It was ol infecting a field near Yankton." In North Dakota, fr Bolley, it is learned that "the disease * * * di much headway upon the garden plot of asparagus u summer, when the attack was general and very destr crop began to yellow early in August, and by the last we when it should have been very green, it was strictly bro up. * * * This season has been simply a good with a little excess of rain in the early part of July."

In matter of range, record is made of the rust having b in Wisconsin, and that it is now as far southwest as Te seems to be in a violent form. From the notes upon t various States for the present year, it is not clear that th relation between the weather and the amount of rust. only one of the controlling factors.

In our own State it is gathered from personal observa sation with asparagus growers visiting the Station and other accurate observers, that the rust has not been as year. Why there is a decrease may not be easy to dete present season has been noted for its moisture and high in summer. For example, the rainfall for the three sur for this year were: June, 3.54; July, 5.87; August, 9. of 18.84 inches (see table elsewhere), while last year the gave 3.08, 4.74 and 2.68 inches, respectively, or a to inches. It is seen that the summer rainfall this seaso double that of 1900. To show that the precipitation cessive, it is stated that the average rainfall for June, Jul for the last twelve years, including the present excessive inches. It is only suggested that in this increased amour there may have been a condition favoring a greater g asparagus and a consequent increased power over the e also possible that the rains may have served to wash th the smooth stems before they had time to gain a footho

Another point of climatic difference this season, that it from others, is the excessive heat of July, which wa

of the average of the past twelve years. As a rule, one July or January, etc., varies but slightly from the others, fore, a seemingly small increase or decrease in the total nperature is a great deal, and marks the month in which s either hot or cold. How this increased heat may have e rust is not clear, but it possibly was advantageous to the plants, giving them greater vigor and consequent resistant

t may be that the considerable decrease of the rust may due to the effect of the natural enemies, the darluca in which has been working unknown to the asparagus growers and its presence is a hopeful sign here among fungi, as with nsects when some other insect is its parasite.

reason for the decrease may be the introduction of the ck and the larger acreage of the "Palmetto," both of s are far less susceptible to the rust than the varieties that go were the standard sorts.

rd for the year is encouraging, for, while it shows that the e enemy is no less widespread, there are indications of its ness being abated. If much of the decrease of the past been due to the peculiarities of the season, as further ns may establish, it would be important information upon hand.

Asparagus Rust on the College Farm.

ber 18th an inspection was made of the four plots of row by row, and not plant by plant, as formerly. The l showed much green, and was in a far superior condition last year, and better than in 1897, when the first observa- records were made for this field. The first evident thing mparative absence of the rust from the "Palmetto" vari- ne three rows of this sort in each plot were easily selected others, because of the deep green color and a large size of

er sort, "Argenteuil," of which there is but a single row, ual exemption, but this is of younger plants than the " and much smaller.

to make a more definite record, percentages are assigned ount of rust, as in former years. Upon the same basis as years, the "Palmetto" does not show more than 20 per e rust, and the same is true of the "Argenteuil." There

seemed to be no observed difference among the ot namely, "Mammoth," "Elmira," "Columbian," "Brunswick" and "Cross Bred," and for these the re cent. of rustiness.

The same area gave 77 per cent. last year.

It was observed that the rust was much more abunc west than on the east side of the plants, and it is sugg dew dried off quicker on the side toward the morn afternoon sun, and then the spores did not have as g tunity to infect the plants as upon the west side, wher remained longer.

EXPERIMENTS WITH PEAR BLIGHT

Owing to the change of management of the pear orch the experiments with pear blight were being carried on of necessity, brought to a close, and here is given the four preceding years.

The plan of the experiments is given below :

	CULTIVATED ROWS.				S
	Barnyard manure.	Nothing.	Commerc'l fertilizers.	Unchanged.	Barnyard manure.
Row 1 { Winter (January) Pruning. }	1	2	3	4	5
Row 2 { Winter and Summer (January and July) Pruning. }	8	9	10	11	12
Row 3 { Summer (July) Pruning. }	15	16	17	18	19
Row 4—Check	22	23	24	25	26
Row 5 { Winter (January) Pruning. }	29	30	31	32	33
Row 6 { Winter and Summer (January and July) Pruning. }	36	37	38	39	40
Row 7 { Summer (July) Pruning. }	43	44	45	46	47

Fig. 2.

Plan of the Pear Orchard Experiment; the numbers represent th

s for the first year were given in detail upon pages he Report for 1897. The blight had been severe over the r orchard, then twelve years from setting, and from it 49 trees was selected for its uniformity in size of trees of the disease.

een from the above scheme that in the rows running in (up and down) all the trees in a given row receive the tment, while in the rows running at right angles to these pruned alike. Three rows are kept in sod and three ultivation. The row lying between these two belts of s treated the same as the other portions of the orchard, nded the experiment block upon all sides.

ach of the sod (row 1) and the cultivated belts (row 5) yard manure in duplicate amounts, namely, five tons mixture of horse and cow manure well rotted. Two rows 3 and 7), similarly situated, received commercial sisting of equal parts of ground bone, acid phosphate of potash, and at the rate of 900 pounds per acre. Rows ived no manure or fertilizer and separated each of the f rows.

d had been under cultivation, and the ground prepara- in seeding down, upon the 15th day of October, 1896, ler the right-hand three rows of trees. A mixture of clover was used; the catch was fine and a rank growth round by the next July.

ning experiments the rows were taken at right angles to nent above described, and consisted in only two points namely, in the times of the removal of the blighted rees of the upper row were pruned only in January of the row next below, in both January and July, and in only in July. The middle row of the seven received nd rows 5, 6 and 7 were a duplicate of rows 1, 2 and 3,

uning was in January, 1897, and, following a season of it, was very severe—so much so that more than half of me of the trees were removed, many of the large limbs y removed. Any branch showing the dead tips and hes were cut below the latter.

y pruning only twigs showing the dead, leafless tips of struction, and the dead twigs with their blighted leaves that had been killed the present season, were removed.

In the summer pruning the trees were not cut nearly so s in the winter, because the green foliage served as a guid the blighted patches upon the branches. The average len summer prunings was not far from three feet, while that of was perhaps three times as long.

The following table shows the amount of pruning each tr in terms of branches for the four years :

79	16	10	14	29	12
27 Died.	38	48	9 Died.	62	10 Died.
44	25	85	82	58	116
....	....	....	Died.	....	....
4	4	....	18	7	1
5	6	17	25	34	54
11	32	34	39	.... Died.	148 Died.

Seven of the trees died during the four years and their p reset with young specimens of the same variety.

The following table shows the total crop, tree by tree, fo years, in terms, of baskets holding five-eighths of a bushel

1....................	46	41	24.5	15	26	14.5	25
2....................	5	42.5	35.5	00	29.5	34	28
3....................	47.5	39	31	37.5	38.25	40	31
4....................	35	52	37.5	27.25	39.50	40.5	16
5....................	42	45.5	37	32	33.75	32	33
6....................	33	30	36	44	34	47.5	35
7....................	50	42.25	38.5	39.5	00	31	40
Totals.......	258.5	292.25	240	195.25	201	244.5	20

t of the death of certain trees, seven in all, and a large t is difficult to derive any results from the four years of eriod all too short for experiments of this kind.

uit from all trees that died during the four years is average for each row is by years as follows :

	1897.	1898.	1899.	1900.	Average.
....	4.9	2.64	10.5	10.1	7.04
....	4.8	3.30	15.4	12 2	8.92
....	5.0	6.03	15.9	10.7	9.47
....	4 4	6.00	14.7	14 0	9.77
....	4.8	5.25	15.1	12.0	9.29
....	3 8	4.60	14.7	14 0	9 27
....	4.9	5.54	18 5	13.6	10.63

he largest yield was during the last two years. The not show any remarkable variations in yield, excepting quite low and row 7 considerably above the others, the being very near the same figure. The unpruned row better than the average of the treated trees.

ing table is of the averages for the rows with soil treatmon :

	Row 1.	Row 2.	Row 3.	Row 4.	Row 5.	Row 6.	Row 7.
.....	5.43	5.18	2.93	3.50	5.17	4.64	4.54
.....	5.83	5 57	4.93	4.37	4.50	4 35	4.18
.....	17.60	18.00	13.70	13.00	13.80	16.30	13.30
.....	13.70	14.40	10.90	13.60	10.00	11.60	11.50
ge...	10.64	10.79	8.11	8.62	8 37	9 22	8.38

clusion is to be drawn from the yield of crop, the averothing striking for either the sod treatment or the cultie soil. It is to be noted that the best yield in the ea was unmanured, and the same is true for the portion the differences are so small that the individuality of the account for the variation. With the cultivated land, nure gave better results than the commercial fertilizers, od land the two corresponding rows were the same. If indicated, it is that the soil of this orchard was sufficir a full yield of Keiffer pears without additional fertilizst the four years covered by the experiment.

ROOT PARASITES.

Early in the season Hon. E. T. Gill, of Burlington co specimens of a weed that was found in considerable ab his clover field. It proved to be the clover broom-rape. flowering plant that is closely related to the "Snap Drag garden, and the "Toad Flax," or "Butter and Eggs," weed of the fields. The plant in question has a stran fastening upon the roots of the clover plant and robbin broom-rape, in other words, is a parasite and shows i method of getting its living by being devoid of the ordi so essential to plants that get their food out of the crude of the earth and air. The broom-rape consists, therefore limited root system, which is fastened to the roots of known as its host plant, from which a comparatively s yellowish-brown stem arises for a foot to twenty inche numerous sharp-pointed brown scales for leaves, of no g to the plant, and a spike of blossoms that are of good si color a mixture of yellow and blue.

The photo-engraving (Plate VIII.) gives three of the b plants from which the earth has been washed, and showin liar method of attachment to the clover roots. The one i dle is the largest of the many sent by Mr. Gill, and show being attached to one of the side roots of the clover, the pa gain enough nourishment to make a large stem, shaped whip, with the large end attached to the host and bearing flowers throughout the whole length of the portion exten ground. Clover that is thus attacked cannot make a s growth, and from the subterranean nature of the pest early growth, any remedy is not easily applied.

In the present case it seems as if the seed of the broom- into the soil along with that of the clover, but as all of of seed had been sown, there was no opportunity upon t the Experiment Station to make an examination. The se broom-rape (*Orobanche minor* J. E. S.), as with all the othe small and could pass as "dust" with the clover seed, and is neither easily detected nor knowingly removed. If on picious of the presence of this enemy, the clover seed especially cleaned, and even soaked in water, to remove broom-rape seed.

PLATE VIII.

Three broom-rape plants upon red clover roots.

PLATE VIII.

Specimen of broom-rape upon tomato roots.

weed is found in the field it should be dug up and d of course no clover seed saved from the infested area. y, in this country, this parasite has not become generally but in Europe, from which it came to us, it is more

,* in his illustrated bulletin upon this subject, states that been in Kentucky for at least ten years. The parasite and tobacco, in some cases to the extent of 50 per cent. One observer states that he has seen it upon tomato. crops, burning over infested fields, care in collecting nting and the use of fertilizers to stimulate growth of ggested as methods of prevention of injury. "Gas-lime land in the fall has been found useful in destroying the eeds."

ntucky Station Report, 1896, Professor Garman states m-rape was found upon the roots of cabbage, rape and urse; but all attempts to cause it to establish itself on clover, wheat and potatoes have failed.

Broom-Rape Upon Tomato.

past season a single tomato plant in the Experiment infested with a broom-rape. This is a different species ove considered, upon the clover, but of the same genus nd is called *Orobanche ramosa* L., because of its habit of The parasite fastened itself upon one of the several roots plant and produced a base of considerable size below which a cluster of branching stems arose, bearing the yellow flowers above ground in early July. The photo-ate VIII.) shows the parasite after the soil had been ned away; but the flowers had become withered before as secured. The similarities between the parasite of nd the clover may be seen from the plate, the chief ap-nce being in the one having a single stalk and the other pacted at the base.

ting to note that the branched broom-rape is a common the roots of hemp and tobacco, in Kentucky, where it ous pest. The tomato belongs to the same family with and therefore, as these parasites go, it might be ex-uch nearly-related plants.

Kentucky Experiment Station, 1890.

Like the clover pest, this one is from Europe, where
structive, and tobacco and hemp culture is sometimes susp
a time upon badly-infested areas, that the soil may becom
of this root parasite.

ERGOT UPON GRASS.

Mr. A. M. Newman, Delaware, Warren county, made c
early in the season, of a growth upon the grass of a low
which, upon the examination of specimens, proved to be
The grass in question is known as "Reed Canary Grass"
Arundinacea L.), which produces a rank growth of fair
surmounted by plumes six inches or more in length. In th
the ergot appears as dark, hard masses, which look like
grains, while in fact they are due to a fungus that takes p
of the grain when quite small, and, instead of an ordina
hard body is produced several times the size of the norm
See Plate IX.

A similar growth is met with upon the rye and many of t
and grasses. When upon the rye it is often called "Spur
because of the hard grains, being, in size, shape and extre
ness, somewhat like the spurs of a cock. These ergots are
liar in being very poisonous, and that upon the rye, wh
with the ordinary grains and eaten in bread, has often pro
to the human subject. This fungus growth produces a disea
as "ergotism," which is recognized by a loss of the u
extremities. Thus, a person may lose a finger or a whole
a sort of amputation, the circulation stopping and the part
away, leaving the stump of finger, arm or leg. When live
the ergoted grass in excess, the animals suffer in the same
ergotism. Whole herds have perished in the West from th
as have entire villages of people in Europe, the latter largel
of a lack of care in separating the diseased grains from the

It is well for farmers to be aware of the nature of the ou
that may occur upon the heads of grains and grasses, and
precautions necessary to avoid ergotism.

As the disease is confined to the heads, it follows that
run no risks in ordinary pasturage until the grasses go to se

It is a fact that the ergoted grasses are more apt to be i
land than where the soil is dry, and it is from the wild gr
streams that the most trouble is apt to arise.

NOTES UPON CORN SMUT.

of corn was more than usually abundant the present particularly so upon the early crop. In whole fields it es difficult to find a single tassel that did not show the ften so badly that the whole top of the plant drooped e extra weight due to the smutted tassel. Soon after, owed in the ear, and as the group of leaves out of which was smutted, it seemed likely that the infection of the the tassel above.

ving (Plate IX.) shows an ear of sweet corn badly , an infested tassel at *b*, a mature stage of the smut upon he joint at *c*, and the form often met with this year upon shown at *d*.

THE BLIGHT OF CUCUMBERS.

been much complaint of blight upon melons, particu- taloupes. An examination of the fields shows that the in apparent good health until the middle of August, its were nearly full size. At that time the foliage be- potted with yellow, soon turned brown and coiled up, ruit without any foliage to furnish them the sustenance they consequently became shriveled and worthless.

pic examination of the leaves showed that the trouble y due to the cucumber mildew (*Plasmopara Cubensis* B. n was favored in its growth and fatal developments by s of the weather.

w may be determined in a general way by the charac- bove—that is, the yellow spots upon the upper surface llowed by the brown color and coloring of the foliage. other diseases of the melon tribe of plants, but none that his way. That there is a remedy at hand is beyond t the disease is so rapid in its growth that it needs to be any signs of the trouble are manifest. For example, resent season a plot of cucumbers has been kept in full orous growth, upon the Experiment Area, by the use of ıx, while a field of untreated muskmelons, not far away susceptible, was entirely ruined by the first of September. periment Stations have been seeking for remedies for d cucumber mildew, and all find a satisfactory one in

the spraying, provided it is done early, in anticipation of the that may come with great force when the conditions of war moisture prevail.

THE MILDEW OF THE GRAPE.

Last year (1900) the mildew was very abundant upon th vine at the time that the plants were in bloom. Photograp taken of canes, flower clusters and leaves, showing the m great abundance. (See last Report, Plate X.) This year t vines were watched closely and were sprayed with fungici attempt to check the growth of the mildew. But no mildew upon the young clusters, canes or foliage until about the firs tember, when the appearance of the young canes and leav sponded well with the same parts in the springtime of last y mildew was met with upon the clusters, which, at that ti maturing the fruit.

It is remarkable that the results of the two years shou different. This leads to a study of the conditions surroun plants for the two seasons. It is seen that the rainfall was s unusual for the period under consideration, there being ne and a half inches (9.43) for August to 4.23 for same mon previous year. This does not, however, explain the non-ap of the mildew in the spring, when the rainfall did not diff for the two spring seasons.

TULIP MOULD.

A grower of Cape May county made complaint that his tu diseased, and, upon request, sent specimens for examinati trouble was diagnosed as the Tulip Mould, which is due to *Botrytis parasitica* Cav. Upon this subject Massee* states th tivated tulips are often killed by a mould, which forms oliv minutely, velvety patches on the stem, leaves and flower later stage, smooth, lentil-shaped sclerotia, at first grey, the appear, mostly in the outer parts of the bulb, sometimes numerous as to form black crusts. Preventive means: W mould is observed the plant should be taken up and bu prevent the formation of the sclerotia, some of which

* Plant Diseases, p. 158.

ie soil, close to the bulb, and thus endanger subsequent e trouble is figured by Cavara*.

tis in question is closely related to several others, and the one causing a serious disease among lilies, investi- . Marshall Ward†, in England, and by Mr. S. S. Kean, s were published, with colored plate, in the "Botanical r January, 1890. "Professor Ward calls the lily dis- he most annoying pests that the horticulturist has had m of late. The disease first shows itself as small, rusty he buds and leaves, and, by their enlarging in the blos- ined. This botrytis consists of coarse threads, which rections through the attacked branched stalks, bearing f spores."

of mould is common upon many plants, and at times is tive to root crops, as turnip and carrot. The onion, ous plant, is often attacked by the same or a similar (Botrytis). The multitudes of spores borne upon the ranches germinate quickly, and, when lying upon the little leaf, will bore their tubes through the epidermis. nside, the thread increases in size and grows rapidly in hing and causing decay as it pushes along. After the gus has grown for a while it may produce dark, hard peculiar twisting and knotting of its threads. These or sclerotia, remain uninjured through the winter, and comes they produce peculiar, trumpet-shaped outgrowths, give rise to multitudes of spores. These are set free, their way to the young lily, produce the destructive gray These spores, by their large numbers and quick growth, is possible for the lily disease to spread rapidly. The ond of moisture, and, in a dry season, the lilies may be Kean suggests, as a remedy, "the planting of some other nate rows, which, with high and spreading foliage, will ollection of the dew upon the leaves and thus check the ependent upon moisture for its propagation."

mould (*Botrytis galanthina* Berk.) is upon the "snow- nt closely related to tulip and lily. As this produces of sclerotia, it, like the others, may be classed in the tinia, as *S. galanthina* Lud. and other similar cases, so ruiting form associated with the sclerotids is determined.

. Veg. 10, Tab, VI., Figs. 1-4.
otany, Vol. II., pp. 319-382, 1888.

There is a form or species (*Sclerotina bulborum* Wak.) onion. Others are upon the wind flower (*S. tuberosa* Fckl. (*Botrytis vulgaris* Fr.), eggplant fruit (*B. fascicularis* Sa another is common upon carnation blooms.

The most common gray mould is *Botrytis cineria* Pers., with an ascoform, the *Sclerotinia Fuckeliana* DeBy. The fo older name was given to the more conspicuous stage of th which may be met with upon decaying vegetation quite The second and "perfect form," as it is called, is less com therefore, the confusion in the determination of a species, perfect stage, is present with the mould form.

The tulip plants that were affected were set in the previou the bulbs being procured direct from Holland. The plan same bed where the mould appeared last year were the wo Some specimens of *Lilium candidum*, growing near tulips, w ently affected with the same trouble.

FUNGI AS RELATED TO WEATHER.

In temperature 1901 had a cold February, with a very that continued into August. There was an excess of rai and July, with an official record for August as follows: " cipitation, the heaviest ever recorded during any August Service was established, came in the form of severe local storms. * * * The average (rainfall) for the month, 9.43 is 5.22 above the normal, and 6.75 above the average fo responding month of 1900."

The year has been one in which there has been very sev among the truck crops throughout the State; but perhap has suffered more than the muskmelon (citron, canteloup crop has been ruined in some parts of the State, and this w due to the remarkable development and spread of a mildew *para cubensis* B. & C.)

This is a fungus quite closely related to the mildew of and in its need of moisture for its spread resembles the on the rot of potatoes. It is not unlikely that the unusual te and moisture at the time when the melons were growing mo served to develop this enemy to the destruction of the form

It is true that persons who lost their fields will have less escaping the scourge next season, the conditions remaining

ie stock of the germs of the disease that have accumu-
sent year.

possible, as with potatoes, to grow the crop so early as
mildew, which does not come until the vines are well
Some growers were able, this season, to get a portion of
l by extra efforts towards earliness something more may

r of asparagus rust is treated elsewhere, and, in passing,
id that this is a fungus that necessarily must make its
and it is probable that the conditions of late summer
have not been as favorable for the rust as for the past
It seems to be a fact that the asparagus beds were in
condition in October than formerly, some of them being

ing items are gathered from the "Crop Bulletin," issued
Weather Service during the growing season :

May—"Heavy rains," "Soil full of water," "Potatoes
nxiety concerning extent of rot," "Lima beans and
tted badly."

-"Frequent heavy showers," "Much seed has rotted in
' June 11th—"Cherries rotting on the trees," "Corn
ine 18th—"High temperature," "Plums and straw-
blighted," "Potato crop poor." June 25th—"Cool
ruit drops badly," "Considerable red rust in wheat,"
g."

"Rain greatly needed," "Much rust," "Oats badly
rust," "Cherry trees blighted and crop ruined."
Intensely hot weather," "Frequent showers," "Oats
Potatoes injured." July 16th—"Cool, cloudy and
weather," "Wheat and rye sprouting in sheaves,"
toes almost a failure." July 23d—"Showers almost
ain damaged from sprouting." "Apples, plums and
till dropping from the trees," "Appearances of blight"
July 31st—"Plums and grapes rotting."

h—"Weather normal," "Tomatoes poor." August
vy rains," "Melons late," "Canteloupes * * *
d," "Tomatoes dropping off." August 20th—"Toma-
" "Plums rotting," "Peaches forcing," "Canteloupes
August 27th—"Warm, foggy weather," "Peaches,
atoes and grapes rotting."

The following table shows the temperature in degrees rainfall in inches for the present year, and the average fo twelve years.

Month.	Temperature. 1901.	Temperature. Average 12 years.	Rai 1901.	Ave
January	30.4	31.4	3.66	
February	25.4	30.9	4.50	
March	39.2	38.7	3.89	
April	48.3	50.0	3.42	
May	58.6	60.7	4.50	
June	70.0	70.1	3.54	
July	77.3	73.9	5.87	
August	73.8	72.6	9.43	
September	66.8	66.1	3.38	
October	54.4	53.9	1.93	
November	.....	.....	.....	
December	.....	.....	.....	

THE NEW GREENHOUSE.

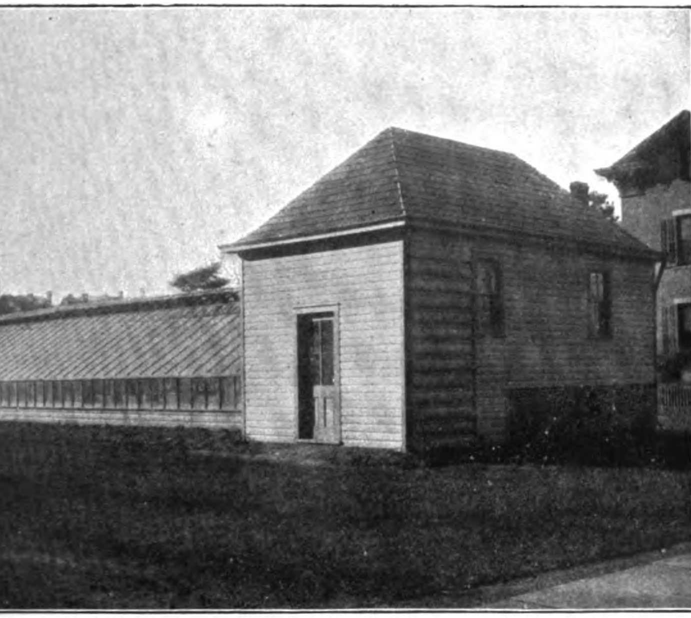
The Botanical Department is now provided with a pla located near to the Experiment Station building, and there to the laboratory and herbarium. It consists of a glass-hou 68 feet, and a head-house, 12 by 24 feet. The main entran with the earth, and from the large vestibule the boile reached by a few steps. Above the heater and coal-bin is work-room.

From the vestibule the door leads directly into the pla which is divided crosswise, near the middle, into two roo independently, so that the hot water may give different a heat as required. The general appearance of the whole h be obtained from the upper engraving in Plate X.

SEEDLESS TOMATOES.

Dr. E. L. Sturtevant, in his excellent paper upon " Fruits,"* mentions no less than sixty species of plants of which have been known to be seedless, either occasional regular thing, Under "Tomato" his statements are very omitting the table, are as follows : "It is a matter of co servation that the finest quality of tomato fruit contains fe than do those of inferior varieties. Burr also says there is

* "Memoirs of the Torrey Botanical Club," vol. I., No. 4, pp. 141-188,



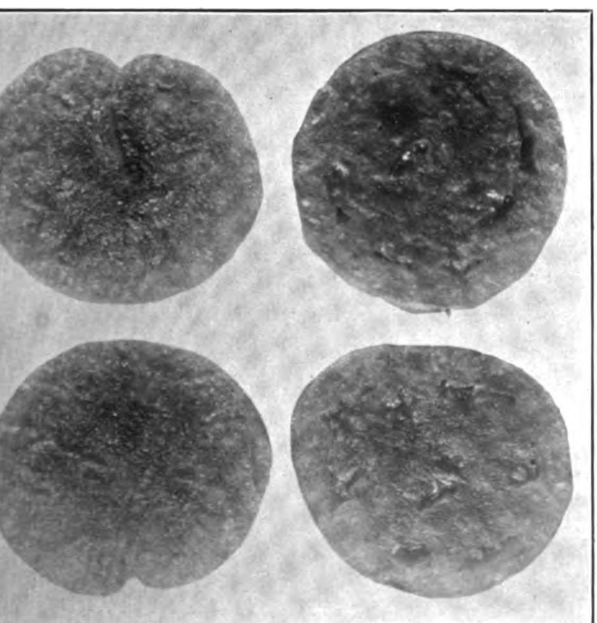


PLATE X.

ouse of the Botanical Department (cut from True Bull. 93 U. S. Dept. of Agriculture). Below—Seedless tomatoes in section as grown under glass.

h and handsome, with few seeds." It is found that eferred to, in his book,* now approaching old age, but le information, adds but little to Dr. Sturtevant's state- says, under "Seedless Tomato," "Very similar to, if with, 'Perfected Fruit,' almost rose-red, solid and with few seeds." The "Perfected," including the so- less," it is stated, is an "improved sub-variety ob- he Common Large Red by cultivation and selection." uote: "From the time of the introduction of the general use in this country, the Large Red was almost cultivated or even commonly known."

s show that what was called the "Seedless Tomato" n name; that it came upon the horticultural horizon be- lopment of the "Trophy" and its class, and it was a of the old, original red tomato, and is now lost from ond fact of special value is Dr. Sturtevant's opinion nparatively high quality of seedless tomatoes and the ving inference that the reduction of the seeds would be value to the fruit.

s an introductory, it may be of interest to state that edless tomatoes have been produced at the New Jersey Station, and the following is a record of how the desired quite novel fruit was obtained:

ding of tomatoes, that has been going on for some years, eties have been employed, namely, the "Dwarf Cham- enting the stiff-stemmed, upright type, sometimes called tomatoes, and the "Golden Sunrise," which is a low- rge, rapid-growing variety, practically the opposite of tioned. The "Champion" bears a medium-sized, red e "Sunrise" has a large, golden-yellow berry. These ve to be sufficiently distinct for the breaking up of their rought together in the process of crossing. As a result, ny offsprings, that combine closely some of the character- parents, while others are left unchanged. This is he stems and foliage, and perhaps more noticeably in ich may be mottled with the red and yellow. One of ght, and being reached, is a fruit with a blush like a peach, at the same time being of high quality and orous and prolific plants.

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and Garden Vegetables of America," Fearing Burr, Jr., 1865.

Last year there were two plants (Nos. 67, 177) which s
most remarkable vigor, overreaching the ordinary plants
same mother fruit surrounding them. These "Giants,"
were called, both resulted from crosses of "Champion" upo
rise," and their fruits were red, like the pollen-plant, while
of vine they exceeded that of the seed parent. Number 67
eighty-three fruits, all of them uniformly of small size, ave
inch and a quarter in diameter, with the seed cavities, four
number, filled with a pulp but bearing only a few seeds
dozen or less.

The second very exceptional plant (No. 177), the greate
of all, bore only twenty fruits, red, like those of No. 67, b
what smaller and with the seed almost entirely absent fr
all. In these the seed cavities were nearly obliterated, and
became a nearly even mass of flesh, firm in texture and of
quality.

Toward the close of the season the stems of both the abo
were layered, and cuttings were also taken, and thereby ma
were obtained that, taken into the greenhouse, bloomed an
during the winter. Several of these fruits were entirely s
any provision for seed production had disappeared. Frui
character are shown in the lower half of Plate X.

There is still much to be done to increase the size of t
which, if accomplished by breeding with normal plants, r
tralize all that has been gained in the way of seedless fru
aim is to reduce the seed production to a minimum and
come it entirely; in short, to have a fruit of good size, wi
solid flesh, in which may be only enough of seeds to pre
present way of propagation instead of requiring the gard
trucker to resort to non-seed methods, as is necessary
modern pineapple, banana, navel orange and the still late
lemon.

It may not be foreign to the subject in hand to state that
lings from these giant plants proved to be a very variable
no two alike. Some were malformed dwarfs, that produc
a single cotyledon, no plumule, and failed to grow, while ot
misshapen in stem and leaf. Some were of the "Champio
others resembled the "Sunrise." Between the lines, the
of the problems of evolution may read some things that,
conclusive, are certainly suggestive. The red and yello
chosen for the breeding, were widely enough separated to th

s from the track and upset the ordinary prolific methods on by seed. Out of the wreck—to continue the figure— to rescue by careful combination a form that, in time, to maintain itself with profit to mankind.*

TUDY OF DIMORPHISM IN BUCKWHEAT.

t is one of the cultivated plants that has its flowers -that is, with two lengths to the stamens and two to the e plant, for example, has the pistil with long styles and is, and another with the three styles of the pistil short nens long. The plan in this is for the insect visitants to llen of the long stamens of one flower and deposit it upon ie long styles of another flower, and the pollen of short he stigmas of short-styled pistils. This is done without intention on the part of the insect, for a certain portion will come against the long stamen and the long style, r portion touches the shorter stamen and the correspond- This dimorphic type of blossom is generally understood purpose of wide fertilization—that is, the impregnation cell with the male-cell produced by another flower.

this view of the case, the point of the experiment was to hether any condition of growth or previous parentage uence in determining the particular form that the flowers idual plant assumed.

the greenhouse experiments were saved from long-styled ort-styled plants, selected from a plot grown in the field summer. The first sowing was made in boxes one by are and six inches deep, on October 24th, according to g schedule:

Seed from long-styled plants, sown in poor soil.
Seed from short-styled plants, sown in poor soil.
Seed from long-styled plants, sown in medium soil.
Seed from short-styled plants, sown in medium soil.
Seed mixed, but from plants grown upon heavily- il.
Seed mixed, but from plants grown upon poor soil.

---

pon this general subject of "Experiments with Tomatoes," given by re the Denver meeting of the Society for the Promotion of Agricul- n August, contained some of the above facts.

The flowers were counted upon November 27th, with the f
results:

	Long-styled.	Sh
Box I	20	
Box II	11	
Box III	11	
Box IV	22	
Box V	25	
Box VI	14	
Totals	98	

The short-styled form was more numerous as a whole, bu
in three boxes, namely, Nos. 1, 4 and 5. The first four b
comparable, and here it is seen that the two boxes with "lo
seed" gave 31 long-styled plants and 29 short-styled plan
the two boxes with "short-styled seed" produced 33 lo
plants and 45 short-styled plants. In each instance the for
flower in the mother plant was in excess of the other type.

The poor soil gave 31 long-styled and 37 short-styled plan
the medium soil produced 33 long-styled or 37 short-styled
or there is no evidence in this case of any influence on the pa
soil.

Boxes 5 and 6 show that the long-styled plants are more n
when the mother plant has grown upon very rich soil an
fewer when the mother plants were upon poor soil.

On February 1st a duplicate of the above set was count
the following results:

	Long-styled.	Sh
Box I	9	
Box II	12	
Box III	12	
Box IV	13	
Box V	11	
Box VI	11	
Totals	68	

Here the totals are nearly the same. The two boxes with
styled seed" gave 21 long-styled plants and 26 short-styled
while the two boxes with "short-styled seed" produced 2
styled plants and 25 short-styled plants. Here the form of th
in the mother plant was not that of the majority in the offsp

The poor soil gave 21 long-styled plants and 26 short-styled
while the medium soil produced 25 long-styled plants and 2

s. Again, there is no evidence of any soil influence phism. Boxes 5 and 6 show an excess of long-styled reatest when the mother plant had grown upon very rich t that agrees with the duplicate boxes in the first series. y 11th a duplicate of the previous two sets was made, seeds employed is concerned, but the soil used was the boxes and was three-fourths clean sand to one-fourth of therefore the nourishment was scant. The plants were ne following is the result:

	Long-styled.	Short-styled.
..	11	23
..	11	11
..	20	20
..	13	10
..	14	9
..	17	11
otals..	86	84

are nearly the same. The two boxes with "long-styled 31 long-styled plants and 43 short-styled plants, while es with "short-styled seed" produced 25 long-styled 1 short-styled plants. Here the form of the flower in plant does not show any positive influence upon the Boxes 5 and 6 have a large excess of long-styled plants, being when the parent seed was grown upon poor soil. ning the three above sets the following results are ob-

	Long-styled.				Short-styled.			
....	11	9	11 =	40	12	16	23 =	51
....	11	12	11 =	34	25	11	11 =	47
....	11	12	20 =	43	17	10	20 =	47
....	22	13	13 =	48	20	14	10 =	44
....	20	11	14 =	45	18	5.	9 =	32
....	14	11	17 =	42	21	8	11 =	40
....	98	68	86 =	252	113	64	84 =	261

hat the totals for the two forms are practically the same. tyled seed" gave 83 long-styled and 98 short-styled the "short-styled seed" produced 82 long-styled and 91 plants—that is, both forms of mother plants produced the short-styled form.

d seed—that is, without regard to form of parent—that h soil gave 31 long-styled and 23 short-styled plants,

while the poor soil produced 25 long-styled and 29 s plants. So far as these two tests go there is evidence that uring produces an excess of the long-styled, and poor soi of the short-styled, form.

But plants from the same lots of mixed seed grown in quite different results—that is, the greatest excess of the form was from seed grown in ordinary soil and sown in r sand.

In the experiments in growing the third generation from styled and short-styled seed, the results ran as follows:

	Long-styled.
Long-styled seed	12
Short-styled seed	9

This indicates that there may be a tendency for the m to exert some control over the form in the offspring. If tl it might be possible, by constant selection, to do away with other form.

SPRAYING EXPERIMENTS IN GREENHOUS

Only a limited amount of spraying was done other tl destruction of insect enemies. However, a test was mad the powdery mildew upon some of the ornamental plants, lar the phlox, verbena and roses. The broad-leaved plan *tago Rugellii*), grown in the greenhouse for another purpo to be a fine subject for this work, first, because the plan susceptible to the mildew*, and secondly, the leaves are disposed for treatment and quite lasting.

The sprayings were made with a small apparatus, that fine mist, and the plants were treated once in ten days. S stances were used, but, as florists object to any discolor liquids were chiefly employed.

One of the mixtures used is the kerosene emulsion, mad to the following formula: Kerosene, two pints; ivory ounce, and water, eight gallons.

Upon the pholx, verbena and plantain this soon bega

* The species upon the phlox, verbena and plantain, growing close probably *Erysiphe cichoracearum* D C., and of the roses, *Spharotheca hum* as it did not fruit the determination is not made, and is not essential t of the experiment.

PLATE XI.

Mildew Experiments. Upper—On the left, sprayed Phlox plant; on the right, unsp
Lower—On the left, sprayed plantain; on the right, unsprayed plants.

lts, and as the winter progressed it was evident that the ıs able to hold the mildew almost completely in check. were not sprayed became in all instances badly mildewed l, while the treated ones kept nearly free of the fungus a satisfactory growth in all parts.

illustrates the work in spraying. In the upper left-hand ıown a sprayed phlox plant, and on the right, one of the ıtreated. The left-hand box shows five sprayed plantain a similar untreated box at the right.

ALBINISM IN SWEET CORN.

is occasionally met with in animals, as white mice, and white blackbirds. In plants it is often partial and lete, for in plants it is physiologically different from in in its completeness, it is suicidal. The Century Dic- nes albinism in plants as "A condition of flowers or hich they are white instead of having their ordinary g to a persistent deficiency of the usual coloring matter, ıguished from blanching or etiolation where the color xposure to light." Jackson, in his recent "Glossary of ms," states, "Albinism, a disease from absence of normal In corn, albinos are perhaps the least rare; and many white seedlings in the field.

mens that have been under consideration were met with n that resulted from a cross between the "Black Mexi- Egyptian" varieties, and in the progeny of the second rimentation. The 1900 crop was grown from pink grains ll from a single ear of the "Egyptian." (See Report for 439–444.) The one-twentieth acre was so situated that it ortunity for pollination from any other corn, save a few same variety, ninety yards away. It was an inbreeding vay. All of the ears of corn upon the plot in question ally alike, in being thoroughly mixed and nearly equally white and pink or purple grains. In the tests for vital- ɔrn the albinos became a prominent factor, and, in round ıe seedling in ten has proved to be white.

ed corn has been tested in several ways, with the thought ing whether the tendency to albinism is inherent in the ay be developed during germination. First, it was deter- the position upon the cob had nothing to do with this

phenomenon. The much-compressed and misshapen b
no more apt to produce white plants than those fron
of the row; neither are the small tip grains so disp
extremities of the cob produce inferior grains, which
behind in the race of life, and are, for that reason, unfi

The grains were mutilated with the knife by cutting
or less, of the endosperm just after they had become
before in some instances; and while such grains gern
quickly, probably due to the more ready access of wate
a less vigorous growth than uncut grains and showed
percentage of albinos.

As the lack of green is evident from the first, there
use of testing different media for germination; but te
made between blotting-paper in pure sand and in pott
none of these exerted any apparent influence upon albi

The best-matured grains from well-developed ears w
contrast with small grains of less perfect ears, and her
marked difference, the poorly-formed, starved or imm
being more apt to produce the albinos. In one suc
small ear, but with the individual grains of fair size and
ance, produced as high as fifteen albinos out of the
grains taken consecutively from three of the rows.

The grains were germinated with various media, in a da
with the same results as previously determined in the
albinos were easily selected from the time they were two
because of the same pale color as when grown in the ligh
easily distinguished from the straw-color of the seedling
light would have been green. In several instances, whe
seedlings from the dark chamber was brought into diffus
straw-yellow plants quickly became green, and, of course
did not change their color.

Other methods of torture have been indulged in, as th
uncongenial liquids to the seeds, either in sand, soil or
paper; but none of these have resulted in changing th
of the albinos.

Excess of temperature has been applied. Thus, so
have been placed in water on the window-sill, over night
thawed out quickly, and the freezing repeated the next
a corresponding lot of grains from the same ear was plac
moist soil, that offered the best conditions for growth.

lid not force any of the seeds to develop into the albino least, the percentage of white seedlings was not increased. n the color, there is very little difference between the the normals when grown in the dark. They all are tween joints, and soon fall to the ground. In vigor of in all other respects excepting color, there seems to be e between the albinos and the normal plants. In the t so easy to come to this conclusion, for a young corn- uts on its working green color and begins the process of ut, from a large number of observations, it may be said, hat up to the end of two weeks there is very little differ- size of the white and green plants from the same ear. ne the green plants rapidly take the lead, and the lagging e ceased growing at the end of four weeks. These offer an opportunity for the study of several problems trition, in connection with the seed and its accumulated

eem that the treatment of the seed during germination to produce albinos.

housands of grains of many kinds of corn have resulted s, excepting in one lot of 1,000 grains of a pop-corn, re- its rapid germination and vigor when one true albino

e been made with the yellow grains on white ears and the s of yellow ears of field corn, and the same way with it as yet the albino has not appeared among them.

may lie in the crossing that had been produced in 1899, ween two very distinct varieties; one an eight-rowed, nd the other a ten twelve-rowed, white variety. Ears roduced having a goodly number of the dark-purple or It was these colored grains that were selected for the n which the albinos have been obtained.

os are found in tests of the parent stock of "Black nd "Egyptian."

A STUDY OF DODDERS.

e past winter the new greenhouse offered an opportunity of that group of pestiferous plants known as the dodders, hich are particularly destructive to crops, as that upon lax and allied plants.

The seeds of the dodder are not far from the size of t clover, and might be mistaken for alfalfa seed or even that To show the relative size of the seeds of different specie and some of the commercial seeds among which the dodd as foul stuff, the engraving (Plate XII.) has been prepare seeds are shown in groups alternating with groups of seeds forage crops.

A study was made of the germination of the dodder se The dodder root is the first portion to leave the seed-c mination, is colorless, and, while variable with the species seed, near a third of an inch in length. It is distinguish stem by its somewhat greater size, absence of the yell that comes in the seedling when growing in full sunligh lower portion is covered with short root-hairs. Thes scarcely more than in name, being only papillæ upon t arising from the middle of each surface cell in the area distance back from the tip. In some roots the hairs co the tip, there being no root-cap and the end consisting of of nearly equal length. The root grows very little in le plant elongates, and when the stem is two inches long, th a third of an inch in length, is fully grown. The tip o practically the same in structure, whether growing in wat rich soil, with light or darkness. The normal position of nating plantlet is, with its root-tip, only slightly buried in extending upward, forming a "loop" in the stem, just ab the seed-coats, with the large supply of endosperm, still As the growth advances the "loop" increases in size, the stem finally becoming separated from the seed-coats and up free in the air, still with a "loop" near the end. ten days the slender wire-like stem becomes straight and nutrition begins.

All this time the root end has remained comparatively fastened by the root-hairs to the soil, from which it imb The short, stout hairs are particularly interesting in p movement of the protoplasm, that can be readily seen w sixth objective, the flow being along the inner wall of t Under similar circumstances, ordinary seeds, like those of produce a long, slender root, penetrating deeply into showing an evident cap at the end, upon which no root-h until some distance back from the cap, and then they form threads, that are very many times their diameter in len

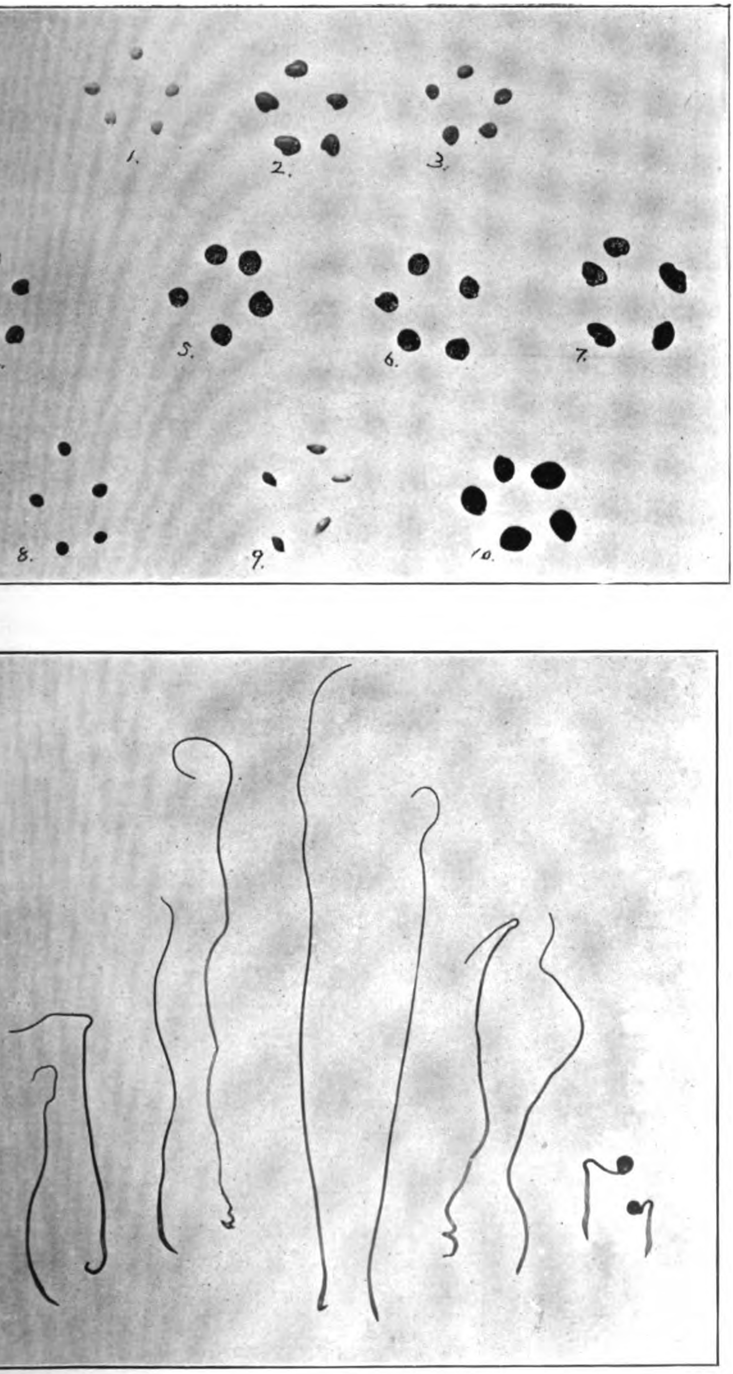


PLATE XII.

ds of six kinds of dodders, Nos. 1, 3, 5, 6, 8 and 10, and of red clover (No. 2), Alfalfa (No. 4),
:e (No. 7), and timothy (No. 9). Lower—Seedlings of dodder from 4 to 10 days old.

›n. The dodder root has no means of penetrating the ›est is only slightly and temporarily fastened to the soil. lies coiled up in the dodder seed, and, with moisture, air ded, the coats burst irregularly, the root tip protrudes, the stem, like a coiled watch-spring, is pulled out by upright "loop," that constantly elongates until the tip aving, in the meantime, absorbed the large stock of hat was packed around the embryo. The iodine test the young stem, as it is being extracted from the seed- ged with starch, the amount gradually diminishing as is approached. The root itself contains very little starch, in cells near to its tip.

short distance from the end of the slender stem, there is ›tch, that may be considered as locating a rudimentary ip is also irregular, but there are none of the well-recog- ts of a formed bud.

the root and the stem extends a central cord of fibrous distinguished from the parenchyma of the main por- irrounds it equally on all sides. It is unbranched, and nature of a tendril of squash than an ordinary stem.

. shows various stages in the germination of the dodder selected from seedlings that were between four and . The sharp-pointed nature of the young roots, as they rom the ruptured seed-coats, is shown in the younger t the right and left sides, while the long, slender stem mewhat larger root portion is shown in the more central The peculiar "loop" near the small stem end is seen in other seedlings. Often the seed-coats are carried up at nd may be moved through circles described by the rotat- at very early develops the tendency to seek some object

g the dodder seedlings upon soil covered with lamp- possible to photograph these nearly white stems. That ch influenced by light was determined by growing the s in saucers, so placed that one side only received the a small hole in the dark chamber.

er was cultivated in the greenhouse upon several host nost interesting of which was that upon the buckwheat. ›ecies *Cuscuta Polygonorum* Eng., found abundantly upon in the neighboring low grounds, were sown along with at, in pots. The above species was selected because its

ordinary hosts, the smartweeds, are closely related to the l
In some trials upon smartweeds in the greenhouse,
evident that the buckwheat is not the first choice of this do
nevertheless, the parasite secured a foothold and develope
flowers of considerable size. There was one serious en
dodder, namely, plant lice, that interfered with the experi
only by constant watching were any results obtained.
seemed to leave everything else in the greenhouse for
feeding ground furnished by the delicate young stems of
and were they at all numerous in clover or flax fields, it
that there could be no harm done to those crops by th
plant parasites. In case of the buckwheat there was a fo
considerable enlargements of the stem at the places entw
dodder. Stems will make a similar growth when stung
and it may be that the attacking plant so irritates the h
abnormal growth follows. It may be an attempt on the
buckwheat to overcome the enemy strengthening itself
otherwise weakened by the enemy. Plate XIII. shows
upon the buckwheat stem.

When dodders climb up woody stems of more than a
no such increase in size is usually met with. Along
streams, alders, birches and other shrubs may be found
fastened to twigs that are several years old, but they prefe
twigs, and may reach them at the top of a button-bal
example, by climbing up some vine and then spreading o
top of the shrub. Impatiens has a succulent stem, that
of the dodders, while any annual weed will answer for the
stone" to higher feeding ground. Clematis and *Mikania*
climbing plants that the little parasitic twiner finds a
means of getting up in the world.

Notes Upon Dodder.*

* The following notes are taken largely from the Experiment Statio

Delaware Bulletin 5, June, 1889, F. D. Chester. Under inspection
found that "in one hundred and forty-eight samples of seeds sold
* * * five contained dodder." E. S. R., I., p. 24.

Colorado Bulletin 8, July, 1889. "The parasitic dodder (Cuscuta
and farmers are urged to prevent its introduction with alfalfa by takir
chase pure seed." E. S. R., I., p. 190.

New Mexico Station Bulletin 2, October, 1890, p. 2. "The do
trifolia) is very troublesome in this region." E. S. R., II., p. 419.

PLATE XIII.
Dodder plants as grown upon buckwheat in the greenhouse.

on Bulletin 15, January, 1892, p. 8, Dodder, F. H Hillman (Fig. 5), l account of plants of the genus Cuscuta and brief descriptions of *ium, C. arvensis*, and *C. denticulata*, with suggestions regarding means on of these parasites. The first-named species is prevalent on alfalfa eeds of *C. arvensis* were found in imported alfalfa seed. The first of alfalfa (from three seeds) showed the effect of the presence of the yellowish-red patches of repressed plants, about which the dodder mat. E. S. R., III., p. —.

lfornia, E. W. Hilgard, pp. 238–252, mentions in list of troublesome *trifolia, C. salina*. E. S. R., III., p. 598.

L. H. Pammel, pp. 72-72, mentions dodder (*Cuscuta trifolia*). E S. R.,

ds, M. Craig, Oregon Station Bulletin 19, May, 1892, p. 21, plate 19, er (*Cuscuta racemosa*) among "the worst weeds in Oregon." E. S. R.,

s from the botanical laboratory and seed-control station of Hamburg, Burchard, p. 20. In the investigation for dodder seed in 60 samples 28 were absolutely free from dodder, 4 contained from 4 to 10 contained from 14 to 11,310 per kg. The species most common was with occasionally *C. Europea*, and more rarely *C. epilinum*. The n North American seed was principally *C. racemosa*. The white d gave 50 per cent. dodder free, the rest containing from 12 to 684 Alsike clover gave 42 per cent. free, and the rest from 36 to 1,129 One lot of lucern from South America contained 23,600 seeds of C. g., and no samples were dodder free. Yellow clover was free from y case. In two samples of timothy 20 to 284 seeds of *C. epithynum* . S. R., V., p. 334.

tario, J. H. Panton (Ontario Agricultural College Bulletin 91, No- 3, p. 7, Fig. 4), mentioned among 25 worst weeds in Ontario dodder . E. S. R., V., p. 529.

he origin of American clover seed, O. Burchard (Landw. Vers. Stat. 3 and 4, pp. 239–346.

g a list of seeds that characterize all American clover seed, probably a of that from the Eastern and Atlantic States. E. S. R., V., p. 912.

destroying dodder. *C. Servais* (Ingen. Agr. Gembloux 5 (1895) No. . The plants on the spots where dodder is present are carefully burned, the spot is worked with hoe or rake, and orchard grass or ck-growing species is planted on the infested spot. The author states s treated may be entirely eradicated within two years. E. S. R., VI.,

chemical history of Cuscuta, G. Barbey (Jour. Pharm. et Chem. 6, 1, No. 3, pp. 107–112), E. S R., VII., p. 407.

uction of Cuscuta, L. Degrully (Prog. Agr. et Vit 12 (1895), No. 51,

suggested for the eradication of the various species of this plant. E. 511.

garden vegetables, B. D. Halsted; Garden and Forest 9 (1896), No. 6, pl 1. Notes are given on a species of Cuscuta growing on onions E. S. R, VIII., p. 234.

An attempt to combat dodder and Rhizoctonia of alfalfa. L. Deg
Agr. et Vit. 26 (1896), No. 31, p. 115.) The use of crude ammonia is
E. S. R., VIII., p 234.

A tobacco sickness of soil (Bu. Baden Landw. Bot. Ver. Sta. (1896)
Pflanzenkrank 6, 1896 No 3 p. 185). Notes are given on the prese
Europœa on tobacco. E. S. R, VIII., p 240.

Dodder in alfalfa (Agr. Jour. Cape Colony 10 (1897), No. 11, pp. 6
recommended to cut the alfalfa from the spots where the dodder oc
them with 6 inches of manure, treading it down well. This kills th
leaves the alfalfa to grow up through the manure. An application o
one pound of sulphate of iron per gallon kills the dodder without inju
E. S. R., IX., p. 143.

Cuscuta monogyna on grapes. A. Rolloff (Ztschr. Pflanzenkrank 7
p. 213). The occurrence of this species of dodder on grape vine is n
placing finely-cut straw thickly about the vines is recommended a
means. E. S. R., IX, p. 653.

Dodders infesting clover and alfalfa, L. H Dewey (U. S. Dept. A
Botany Circ. 14, p 7, Fig. 3. Notes are given on the occurrence of s
species of dodder, methods of propagation, distribution and suggest
eradication. The species in the United States which are considere
economic crops are the following: Alfalfa dodder (*Cuscuta epithymu*
(*C. epilinum*), clover dodder (*C. racemosa chiliana*), warty dodder (*C*
field dodder (*C. arvenses*). E. S. R., X., p. 54.

Two phanærogamous parasites of red clover, B. D. Halsted (Bul
Club. 25 (1893), No. 7, pp. 395–397, Fig. 1). Notes are given on
of Cuscuta epithymum. E. S. R., X., p. 556.

Twelve of Idaho's worst weeds, L. F. Henderson (Idaho Sta. Bull. 1
Fig. 5). Dodder is mentioned in a description of 12 worst weeds of I
with the methods of which they are distributed and suggestions for the
E S. R., X., p. 760.

Cuscuta monogyna on the grape, P. Viala and G. Boyet (Ann. E
Montpelier, 10 (1897–98) pp. 279-304, pl. 1, Fig. 32). A botanical
parasite of the grape vine. The seeds are said to retain their vita
years in the soil, and by care the plant can be exterminated from a vi
time. E. S. R. XI., p. 159.

Dodder affecting alfalfa, E Schribaux (Prog. Agr. et Vit.) (Ed. L'E
No. 34, pp. 229-236; Rev. Gen. Agron (Louvain), 8 (1899), No. 8–9,
The author describes *Cuscuta Gronovii* and states that it is frequen
American clover and alfalfa seed. E. S. R., XI., 462.

The American Cuscuta, E. Schribaux (Jour. Agr. Prat, 1899, 11, N
419, pl. 1). The author figures and describes *Cuscuta Gronovii.* On
fact that this species is said to be parasitic upon a number of pla
thinks that there is danger from its introduction into fields of forage
R., XI, p. 750.

Destruction of Cuscuta by copper sulphate, A. Brandin (Jour. Ag
II., No. 36, pp. 335–336) E. S. R., XI., p. 750.

The occurrence of a new species of Cuscuta on alfalfa, E. Schriba
Agr. Brabant-Hainaut, 1899, pp 716–718).

cumbers under glass, F. C. Stewart, N. Y. State Station Bulletin Reports the occurrence of dodder, probably *Cuscuta Gronovii*, on in the station hot-house. E. S. R., XII, p. 56.

y of flax and clover dodder, G. Wildsdorf (Fuhling's Landw. Zig., reported on dodder seedlings, with reference to the host plant, the thods of attack, and growth and reproduction of the dodder. E. S.

ay crop, B. C. Buffum (Wyoming Station Bulletin 43). Dodder is ie serious foes of alfafa in Wyoming. E. S R., XII., p. 431.

listribution of the species of Cuscuta in North America, A. M. oc. Ind. Acad. Sci., 1898, pp. 214-215). Notes are given on the ribution of the dodders into the different life-zones, as defined by m. E. S. R., XII., p. 720.

on of ripe and half-ripe dodder seed, W. Kinzel (Landw. Vers. 0, Nos. 1–2, pp. 125–132). Studies are reported upon the germina-various degrees of ripeness of *Cuscuta epilinum*, *C. epithymum*, *C. Europæa*. It was found that the half-ripe seeds of these species t vitality to germinate almost as readily as the fully-ripe seed. In germinated quicker than ripe seeds, and when they were found in ie percentage germination was but little inferior to well-ripened or says that *C. plantiflora* is occasionally found in American clover s to be a misstatement, as that species does not appear in any of the treatises of the flora of this country. The species is a South d its reputed presence is probably due to a wrong determination. 960.

SELF-FERTILITY IN BUSH BEANS.

obtain a full demonstration of the statement that beans several tests were made in the greenhouse. Bush beans lleback Wax" sort were grown in pots; as the plants ie of blooming all were removed, and the single plant a glass bell-jar. As the flower-buds appeared, they ved excepting one, which was allowed to bloom entirely he plant. There were six such plants, with their isolated, and they all produced pods of normal size, r, perhaps due to the lack of competition for the nour-yielded the ordinary number of seed. The last linger-o the self-fertility of this bean was removed. Similar le with peas with like results, and it seems to be a fact cies, with their strangely-formed blossoms for attracting ecuring wide fertilization when left to themselves, do nbreed with apparent regularity and ease.

The Dwarfage of Beans by Cutting the Se

Experiments have been made by growing "Saddl beans from seeds that had been cut through shortwis food substance was reduced one-half. This can be soaking the beans until they are softened, when they cu of the two halves, one will contain the seed-bud (plur other is made up of the free ends of the seed-leaves (cot one is in doubt as to which is the bud end, the entire can be planted; of course only the portions containing root will grow. Such halved beans, when planted in with the whole beans, will demonstrate that they wil little quicker than the normal beans, doubtless due ease in taking up the content of water. The plant beans, however, soon pass the plants from the halved the course of three weeks are in every way larger. At the former plants are in bloom, the others are only s buds. The plants from whole beans produced stem inches high, while the halved beans gave plants only fo in height.

This experiment indicates a line of work to reduce the common and lima sorts to bush varieties and any the dwarfage of which may result in plants of increased

In the second place, it emphasizes the value of a la food substance in the seed and the importance of select are well provided in this respect. Large seeds other equal, are superior for plant production, because they percentage of material for the plant to use while gett the soil and air.

A similar study was made of corn, in which it was large part of the starchy material may be removed, and if uninjured, will begin growth much quicker than in s It teaches the lesson of the advantage of rapid access c center of the seed, and suggests that for large, hard se practicable to slightly mutilate the outer portion, so th may be materially hastened.

HE SIMPLE-LEAVED AMPELOPSIS.

f the *Ampelopsis cordata*, kindly furnished by Pro-an, of Ohio University, have been grown for two llis plants upon the greenhouse. They are rapid-with a foliage resembling the smooth-leaved grapes, charm of holding on and remaining green for a month s of the American ivy have become discolored and

same species were sown in the greenhouse and the is spring in the Experiment grounds. These made a l are ready for setting as piazza covers the coming

PORT OF THE ENTOMOLOGIST.

REPORT OF THE ENTOMOLOGIST.

JOHN B. SMITH, SC.D.

GENERAL REVIEW.

n of 1901 was not marked by any unusually destructive on. Some forms became abundant for a time, and ; but the threat was, in most instances, not fulfilled, se was there any wholesale destruction. Yet the aggre-s been nearly as large as usual, some crops suffering ers suffered less.

rological conditions were peculiar. The spring was late, , retarding vegetation and favoring the development of lice. Then came a period of hot, dry weather, which sture and, in turn, checked the growth of crops. The of the early insects was also stopped, to the advantage ther different series. When the drought was finally sture became excessive, and, in some localities, caused ch injury as its lack had previously done. Conditions re, irregular and abnormal, and a corresponding irregu-served in the insect occurrences. So, while the preced-presses the general condition, not all parts of the State affected, some having no excess of rain at any time, did not get all the drought. Insects are very sensitive nditions, and it is quite probable that some of the un-ifferences in local abundance or distribution may be ound to be due to even a slight variation in climatic

Caterpillars.

most characteristic features of the season was the in-rtain species of caterpillars, which, always more or less me this summer in destructive swarms. Others, ordi-

narily rare, occurred in such notable numbers that t
attention, and many species were, in consequence, sent
ment for information.

Fall Web-Worm.

The most prominent of these was the "fall web-worn
late summer and early fall, stripped the leaves from
shade trees, defoliated shrubs and vines, and made its
by crawling into all sorts of unexpected places or droppi
walking beneath infested trees.

This increase was not entirely unexpected. For t
past I had noticed a general occurrence of late nests,
1901, I found an unusual number of moths. I was
therefore, to note early in August the beginnings of nu
on my fruit trees and on the shade trees of the city.
at first upon picking off the leaves or small shoots
webs became visible, and for a week or two anywhere
half a dozen colonies were destroyed every day on alm
other than peach. Yet the colonies kept coming, and
all the trees a heavy dose of arsenate of lead. That settl
and all the later colonies were killed off as soon as they
not another web developed on any of my trees.

The story from other portions of the State was the
very few persons realized the extent of the increase un
were covered. Then came a feeble attempt to burn out
but though this method does very nicely where nests
and no tree has more than one or two, it fails practi
entire tree is spun up. The torch in such cases is lial
least as much injury as the caterpillars could do if left
By the middle of September curious sights appeared
bare of foliage as in mid-winter, with wilting apples or
about; vines with leaf stalks projecting from the ste
shred of leaf tissue left, and shade trees bare, or festoo
and abandoned nests.

Not all kinds of trees were equally infested, and, a
trees, peach escaped almost altogether. Conifers wer
and some varieties of maple suffered little. So, the i
not equally bad everywhere, and locally only isolate
be much infested.

During September, demands came for informatio
remedial measures and inquiries concerning probabi

was then too late to adopt destructive measures, because re practically full grown, and had scattered. From the e end of September they were crawling about everywhere, uch, but evidently seeking a place to spin a cocoon.

Probabilities.

quite safe to prophesy concerning an insect for a year judging from past history and from observations made, to predict that the crop of 1902 will be much smaller 1901. Parasites in great numbers were observed in and sts. I watched one specimen of *Pimpla* for nearly an which time she examined almost every larva in the web egg in most of them. Some were rejected for reasons not discover, but no egg was laid before the caterpillar idly scrutinized.

became epidemic among the insects late in the season. l dying caterpillar could be observed even in August, and ptember dead specimens were not at all uncommon. end of the month, dead, dying or mummied examples y fence, tree and shrub, and additions were constantly number of moribund subjects.

Remedial Measures.

-worm" is a chewer of food, or mandibulate, and feeds f tissue. If we poison this the caterpillar eats of it and contains the essence of our practice against the insect; tirely effective, applications should be made as soon as it nests are to be abundant. Theoretically, the first brood m the eggs in spring should find the foliage thoroughly It is almost as well, however, to defer action until the has gotten pretty well along, as a thorough application is likely to be more generally effective than one made the second brood, spraying should be made as soon as lonies begin to show in any number.

d arsenate of lead and Bowker's "Disparene," which is t, with exc llent effect. The mixture was strong—about n five gallons of water—but I did not harm even the foliage. On orchard trees Paris green will be cheaper, rden I strongly recommend the arsenate of lead.

As many inquiries have been made concerning th defoliation on the trees, it may be added that Dr. Ha anticipate any permanent injury. The leaves were fu most cases, their functions had been pretty well comple destruction did not leave the tree much the worse, affect the maturing of such crops as were borne by the

White-Spotted Tussock Moth.

Another common species that occurred in unusual the white-spotted Tussock or Vaporer moth. The pre with its shining red head, its prominent black hair pen coral-red warts on its yellow body and thick paint back, was seen everywhere in city, town and villag attacked a great range of plants. At Riverton they Cannas on the Dreer nurseries, and it required promp action to destroy them. The species did not become orchards, for there our native birds keep it in check, area of sparrow domination it flourished.

Some complaint was made of an irritant poisoning caterpillar, and this was partly based on facts. The ha is used to form part of its own cocoon, and, to facili interlacing, some of it is spurred or barbed. A roug the individual, and a rubbing of any of these barb hairs into the skin, will set up an unpleasant itchin last for a day or only a few minutes. Rarely, with t there any swelling resembling hives.

There are two broods of this species, and the last, in September, was most troublesome. Again there for remedies, and, long after there was any chance of anything, trees were banded with cotton and the like.

Probabilities.

The prediction made for the "fall web-worm" appl to this species also. There was also an epidemic disea so universal and quite different in character. Its effect the larval tissues to a soft, pasty mass, and many cate be seen in early September, hanging limp and lifeless, position only by a pair of the feet, which were hooked surface on which they rested. Parasites were also p

pearing to be attacked. Out of thirty or forty speci-
e pupæ gathered at one time from one fence, not one
adult, and from nearly all *Hymenopterous* parasites were
theless, egg masses were quite numerous late in Septem-
possible that there will be trouble next summer.

Remedies and Preventives.

is species winter work is practical and may be made
The egg masses are prominent and so easily recognized
nyone can be directed to gather and burn them. This
ill be very few larvæ of the first brood the season fol-
en the larvæ do come in numbers, arsenical poisons are
prescribed for the preceding species.

inx.—This insect was described in the report for 1900
on of our State recorded. During the season of 1901 it
held its own but has added new territory. The cater-
ccur throughout South Jersey, not only in or near towns,
tskirts of and in the pines, where *Catalpa* is not uncom-
New Lisbon the trees in late August had not a leaf re-
at several other points the same appearance was noted.
ay of October half-grown caterpillars were received from
ndicating a very late brood compared with the Burling-
tatus. Most of these, however, it was later reported,
e result of a fungus disease.

the spread northward, along the Delaware, has been
pid, the eastward journey through the central and
on seems to be much slower. Though I looked carefully
in the nurseries on the costal region, no trace was
cal observers have seen nothing of it. The nearest ap-
Atlantic shore is Manchester or Lakehurst, in Ocean

ck Moth.—About mid-summer, complaints of the "horn-
from tomato-growers all over South Jersey; and this
eatened injury. There was considerable foliage devoured
nts were really destroyed; but in most cases growers
nd-picking, or, when the fruit was not too far advanced,
arsenites. After the middle of August little was heard
illars; but the moth became commonly noticed. On
Dickerson brought in about twenty, which were taken

along the bridge crossing the Raritan, at New Bru
could have taken more than as many more without d

It may be noted, incidentally, that arsenate of lead
form of arsenical poison to use on tomatoes.

Swallow-Tail Butterflies.—Among the rarer caterpilla
in unusual numbers during the summer, those of fou
swallow-tail butterflies attracted considerable attent
common was the one feeding on parsley, carrots and
plants, and this is the larva of the *asterias*, or bla
having an oblique bar of yellow spots on all the wing

The second species was larger, with a swollen for
transverse mark back of the head, and two eye-lil
sides. This feeds on magnolia, sassafras and a n
garden plants. It is the larva of the *turnus*, or yell
in which the wings have a broad, black margin.

The third, and least common, is a peculiar gra
mottled form, larger than either of the others, and w
gardens, on fraxinella and other ornamental plants.
of the *cresphontes* butterfly, larger than either of th
with crossed yellow bars on the wings. This species i
to the southward, and its larva is there known as the
sometimes doing considerable mischief in Florida, o

On the *Aristolochia*, or Dutchman's pipe, the bla
philenor butterfly, with its long, black, soft proc
common, and some of the vines were almost or c
defoliated. These are scarcely injurious species; b
pillars were unusually numerous and really attrac
attention, it is deemed proper to mention them here.

One of their peculiarities which was usually refer
pondents was their habit of protruding a pair of fles
behind the head, when irritated. These are defen
disagreeable odor, which deters most things from med

Plant Lice.

This could hardly be called a plant louse year, a
able injury was caused by some of the species durin
of the season. While it was yet wet and cold in
affecting maples began to develop quite raidly; No
pecially, became badly infested and, in some of the c
"honey dew" appeared on the sidewalks beneath

Fig. 1.

Currant leaves attacked by currant plant louse. **From an original photo—somewhat re**

ies developed with their hosts and kept them down numbers until the arrival of hot, dry weather put a injury.

use.—Currants became quite seriously infested locally, others, the row of bushes in my own garden became I had kept rather a close watch early in the season, th found the winter eggs where I had noted the first the day before, the position of the insect giving me an place where its mates, then in the egg stage, could be proved to be on the terminal shoots near the buds. the life history of the insect for a few generations, until nemies and the increasing dry heat caused it to prac- ear. But the currants had suffered considerably and re their crop properly. The leaves began to blister as rst louse began feeding and continued until, on many sound leaf remained. The material gathered in this e used at some future time, when the work can be

—Comparatively few apple lice appeared this year, but oint to a more general occurrence next season, if the itions do not interfere, and in some localities, even this as noticeable injury, as will be seen by referring to the the Crop Bulletin. On trees where no aphids were in the season a considerable scattering appeared in iposition is yet in progress at the date of this writing, mises to be quite a crop of eggs before it is completed. inning of November the apple trees in the Experiment more eggs than ever before in its history.

le Lice have not been nearly so abundant in the orchard sery; in fact, colonies are exceptional as compared with Cratægus is really the only plant upon which I have n numbers, and on this only in nurseries. It is one of t is readily destroyed by fumigation except in the egg l practically none in heavy or clayey soil as compared found in lighter, sandy land.

Lice have become of importance, because delivered s of young plants in some other States. The species ghout the southern, sandy counties, and has at times elds in Ocean, Cape May and Camden counties. It is robable that it occurs in all the strawberry-growing

sections of South Jersey, though it has never done such in
credited to the species in Delaware and Maryland.

To inform our growers on this subject, and also conce
strawberry leaf-roller, whose life history I had completed s
since, Bulletin No. 49 was prepared and distributed in Ma

Melon Lice.—At one period in July it seemed as if there
a serious invasion by this pest, and, as a matter of fact, so
were actually injured; but, the danger passed, the insects
in number quite suddenly, and nothing was seen of them l

The Cherry Louse appeared in great numbers early in t
throughout the State and did serious injury to the cro
Throughout the month of June complaints were received, a
cially in the northern sections, fruit would not ripen or wa
caused to drop on account of the injuries due to these pes
curled up the ends of the shoots, massed on the fruit s
even on the fruit stalks, sucking the juices to weaken the
coating foliage with honey dew to choke it. The usual
fungus appeared promptly, and altogether the trees were a

Plum trees suffered to some extent, but not nearly so muc
Peach escaped very easily. On the latter no real injury wa
though some shoots were curled and twisted.

Woolly Maple Louse.—Besides the ordinary plant louse o
to which reference has been already made, a woolly specie
locally abundant. A correspondent from Vineland sent s
early in July, of which he says: "They rained down upon
and shoulders of a company of people yesterday while sittin
maple tree (*A. dasycarpum*). The ground under the tree
piazza roof and floor were pretty well strewn with them. S
wings and could fly; but I was unable to find a speci
wings this morning." Reports from other sections at a
same time indicate that this early part of July is the pe
general migration of the winged forms. There was no furth
mal increase, and the species was not again reported.

Phylloxera on Hickory.—From Morris and Cumberland
complaints came of curious growths on hickory leaves a
causing the foliage to shrivel, turn brown and to seriously
tree. In one case the statement was that the trees had bee
for several years past. The abnormal growths were galls, m
species of *Phylloxera* which is very common locally on the
hickory sprouts. The galls are soft, bladder-like, and the i
face is closely set with the yellow, black-winged lice.

aware that the life history of this species has been com-
ked out, and can make no present suggestions as to reme-
nt.

The Pea-Louse.

ct has not caused so much injury in New Jersey as it did
d this was for several reasons. First, the season was
insect and favorable to the plants; cold, wet weather
development of the Aphid, and, though it also delayed
of the peas somewhat, the insect never really made up its
he vines were all the better, the earlier varieties making
y heavy crops. A second reason was that many growers
e suggestion made in my last report, and planted no
ure much after June 15th. Those who risked a later
nained practically unharmed because of the weather con-
ady referred to. Thirdly, many of those who grew oats
r late fodder last year, substituted some other crop in
peas. On the College Farm late peas were abandoned
ecause of the injury suffered during the two seasons last
this was good practice was indicated by the fact that in
nber a row of late peas, planted for another purpose, was
uined by the swarms of lice. The crops maturing by the
une were unharmed. Finally, where peas were grown
a systematic warfare was waged against them, and this
ful. It was indicated last year that two growers who
ge acreage of peas had practically solved the problem of
ealing with this insect; but they were not quite ready at
publish results. The machinery employed has now
ted by patents, and no further secrecy is maintained.
are Mr. Asher Brakeley, of Bordentown, and Mr. Joseph
Freehold. The former grows about 500 acres of peas,
bout 1,000, and in each case the product is canned, can-
ng from the middle of June through most or all of July.
, Mr. Asher Brakeley gave an exhibition of the working
ines on a 30-acre field near Bordentown, to which he was
h to invite me. At this date there were few insects on
nd spraying was hardly a necessity except as it prevented
o growth from a sudden increase, and barred the occur-
ge numbers altogether. It was said that the lice were at
eeks later than in 1900, when the fields were swarming

at this date, and the crop harvested on the 10th had be much injured.

Mr. Asher Brakeley disputed the suggestion that the wi came to the pea fields from clover. He has watched the three years and, when it first came, lost considerable m This year he again watched the vines closely, and inst partners and workmen to also watch and report the first of any louse on the vines. There is no clover within sever yards of the pea fields, and no large fields of clover are a mile.

The first insects noticed were wingless; all the watche this, and all agree further, in the statement that no wi had been on the fields this season. There certainly we the 13th of June, so far as I could find, but I would accept too positively the claim that none had been there season. It is so easy to overlook the few migrants that before they are expected and disappear, leaving scattere form the little colonies which are afterward discovered as f ances. That fields are very unequally infested is a comm ence. Mr. Brakeley further asserts, and in this he is correct, that he has had fields of clover adjacent to peas a latter were practically free from lice, while other fields, d any clover patch, were practically destroyed. It is a that there has been no complaint in New Jersey of any injury to clover. It is possible that the life cycle of the i State is somewhat different from that recorded by Professo in Maryland, the difference being due to latitude, but fro cal standpoint this does not seem to be material. The i here given are from the "Rural New Yorker," and wer from photographs made for Prof. Sanderson, of Delawa also at the trial, and who wrote an account of it for the j mentioned. Each sprayer consists of an oblong tank ho 100 gallons. It is of wood, lined with zinc, and divided into two compartments to prevent too much splashing. I is a single-action force-pump with six-inch stroke, geared a chain and sprocket giving four revolutions of the pu one of the wagon-wheel. A pressure of 30–35 pounds is this way. The pump is entirely inside the tank, and th one wheel only. This makes even driving rather har pump rather difficult to get at in case of accident. Below

Fig. 2.

Spraying a pea field; upper figure shows the Brakeley Sprayer in action; lowe
tank for spraying mixture. (From Sanderson in the "Rural New

igging of iron tubes and rods, which may be raised or
vill by means of a lever.

ines spray three rows at one time, and twenty-one nozzles so that an adjusted series of seven sprays each row of machine moves along. For each row there is a series of ibes, two of which, when the machine moves along, run ice of the ground in such a way that they pick up, by every plant that is lodged. These tubes rise and narrow that the vines are at once lifted and brought toward the row. Similar solid rods, also spreading anteriorly and o the centre, engage the vines and keep them erect, so, pass the nozzles, they are as nearly upright as they can

es are of the "Bordeaux" type, throwing a fan-shaped is directed straight down, one from the top is directed other backward. On each side are two nozzles, adjusted different angles, so that every part of the vine is hit between the carrier guides. Thin, sloping boards at the carriers receive any lice that are knocked off, and, s wet with the spray mixture, the specimens receive a full machine is carefully adjusted to match the planter used the peas, and as the sprayer follows the exact route of in every case, the adjustment to the rows is perfect and torn.

ines used by Mr. Joseph Brakeley differ somewhat. They wo rows at a time, because his planters are so adjusted; haft is geared to both wheels, which makes even driving the pumps are entirely above the tank, making them sible at all times in case of need.

rial used is Good's potash whale-oil soap, No. 3, one x gallons of water, and all those concerned agree that it effective and absolutely harmless to the vines under all es. It kills wherever it touches; but, of course, with est machinery, some specimens will escape, especially at re the method of vine growth protects specimens lodged t, but vines once sprayed are safe for ten days thereafter; pt for the very latest varieties, one spraying is sufficient m through. So, while the number of lice on the thirty-as not in any way a menace to the crop on June 13th, it hat a few days more might bring an increase sufficient to rdening of the pods and consequent check to growth.

Therefore, the vines were thoroughly sprayed, and, durin weeks required thereafter to bring them to maturity, there sufficient increase to cause injury.

During the first year or two, many kinds of insecticides experimentally before deciding on the soap. The kerosen was favored as the most promising at first; but it was when the mixture was strong enough to kill the lice, it w ous to the plants; when safe for the plants, and put on du mer day, the kerosene volatilized before it injured the soap mixture proved, after all trials, to be the best, and wa So, before deciding upon the nozzle, the various types market were tested. The Vermorel and its modificatio jected, because they could not be readily cleaned when c cause the amount of spray could not be easily regulated, a for close work the hollow cone of spray covered too mu The Bordeaux nozzle is more wasteful; but a good suppl rial is a desideratum, and the supply is easily regulated. I cleared while the machine is in motion by simply turning ing stop or valve at its mouth, and the fan-shaped spray the surface desired, so that the vines get practically all t that is sprayed. It takes about 50 pounds of soap to spr of vines—that is, 300 gallons of mixture. One machine about five acres when run by a proper man, and when th material is brought to the ground ready mixed. The field treatment, though called thirty acres, had, actually, only t acres full in vines. Six machines began work at eight o'c and finished a little after three P. M., making four acres six hours.

The soap costs, in barrel lots, two and one-half to thre pound. They average it three cents, delivered at Borde it is mixed at the edge of a stream, where a farm tractio geared to a pump. The soap is dissolved in a definite water, and a certain measured quantity is dumped into wagons. These carry 200 gallons, and are rapidly filled b pump. The mixture becomes very effectually stirred i and during the drive to the field. Each supply wago spraying machines. The tanks are set high up, over the ordinary box-wagon, and the machines are filled by a la tached to a faucet at one end. The cost per acre varies $4, according to circumstances. Mr. Asher Brakeley has o invested in his spraying outfit. His bills per day, when

t work, amount to $50 or over, and anywhere from $3 to to the cost per acre of raising the crop; yet the gentle- ave done it seem to think that it pays.

nts, it is definitely proved that where peas are grown on le the insect can be kept in check by using proper ma- l material, and injury to the crop can be prevented. It ved that as a destroying agent whale-oil soap of the ity is satisfactory at the rate of one pound in six gallons This latter point may be made useful in treating garden all areas on which the expensive outfit above decribed be profitably employed. Small or garden areas can be h a knapsack sprayer, while areas an acre or more in ex- quire a barrel or other tank machine upon which a pump t least two lines of hose can be mounted.

t, spraying field peas, planted for fodder, must be consid- tical, and this crop should not be planted for late forage. nmendations concerning the brush-and-cultivator method, n the last report, have lost nothing of their usefulness. Brakeley have not found them practical on their land their special conditions. With other surroundings, and smaller area, this may prove to be the best avail- l.

SCALES.

cts attract attention everywhere, and a greater number of now received at the Station than ever before. Of course, nicious form that most of the correspondents are seeking, o often they prove successful in their search. But there hers, and perhaps the most common form is—

r-Shell Bark-Louse.—This seems to have a greater range of than any other native species, and has been several times injurious to young apples. But it is much more destruc- trees, and finds its best opportunities for development on shade trees and ornamental garden plants. Poplar and times become completely coated with it; lilac is often nders, rhododendron, Rose of Sharon, and a great variety re sometimes seriously injured. In orchards it does not t surroundings, and yields quite readily to insecticide f made early in its development—*i. e.*, the larval or re- age. Its development is slow, there is only one brood, t season males were not noted until the last days of July.

This indicates the middle of August for the beginning of o
by the females. It also suggests that if two sprayings at sl
vals could be made at this period—say July 25th and Au
with either whale-oil soap or kerosene emulsion, a good ef
be produced by killing off the males, and thus preventin
tilization of the females. The soap should be about one
four gallons of water, or stronger on hardier plants, up to
in two gallons of water. The kerosene emulsion may be th
soap formula, used one part in ten of water, or the mecha
ture, using 10 per cent. of kerosene. Of the two, the lat
ferable, and is less likely to cause injury to susceptible tree

Euonymus Scale.—This is allied in appearance to the o
scale, and has been frequently complained of by gardeners
ers of ornamental plants. During the season of 1901, M
Hamlin, of Haddonfield, kindly supplied me with materia
at intervals of a few days, whereby I was enabled to foll
velopment of the species. It appears that there are tw
pupæ of the males occurring early in July, the adults
being numerous on July 13th. Larvæ appeared about t
the month and during early August. The material accum
notes made will be worked over as soon as possible, and
either in a bulletin or in a future report of this departmen

Tulip Soft Scale.—This insect, while not so conspicuously
as it was two or three years ago, was disgustingly common
ous points throughout the State. For some reason, its
were much more abundant than usual, and attracted swar
wasps and flies. Indeed, it was this feature that general
attention to the trees and resulted in the discovery of the i
The little, predatory caterpillar to which I called attenti
vious reports was always present, and in some of the sa
me all the scales had been destroyed by this useful creatur

The Rose Scale.—During the season of 1901 I received f
berry and raspberry-growers several lots of canes quite w
with the Rose scale, *Diaspis Rosæ* Bouché, complaint b
that the new shoots were badly infested. As there is n
usual in a local increase of the species, especially where
are in dense rows, I attached no great importance to the m
did not even mention it in my report. But during the wi
mens kept coming in, and, from the communications recei
apparent that the increase was much more general and
than had been believed.

assistance of Mr. Henry Pfeiffer, of Cologne, who sup-
th specimens throughout the summer, I followed the life
he insect up to the period when egg-laying was general in
utline of this life cycle will be given elsewhere at some
. As to the actual injury caused, opinions differ; but
e insect is of no benefit to the plant. Just why the scale
abundant is a problem, and until this is solved it is im-
say whether the increase will continue, or whether there
ompt return to original insignificance. At all events, it
be ready to deal with the creature should the necessity
se.

San Jose Scale.

s time has been devoted to this insect than in the recently-
though it has yet demanded more attention than any one
. It remains the dominant horticultural factor in certain
ut its extension into previously-uninfested localities is
Where it has become fully established, fruit-growers
the problem squarely, and have, generally speaking, de-
ht.

ar and apple orchards that have been infested for nearly
years are yet bearing fruit, and are a long way from de-
On these trees the insect can be fought and kept in check
unreasonable amount of difficulty. The Keiffer pear,
is resistant, and bears without injury the most radical in-
plications.

d plum succumb most readily, and are, at the same time,
ive to insecticide applications, though the former is much
ptible than the latter.

n difficulty yet is to bring growers to a realizing sense of
n the insect before they learn from actual experience. It
g, however, how much attack some trees will stand with-
nbing. It is not even unusual for a tree, after several
festation, to become entirely clean without any treatment,
nain so in the midst of infestation. These cases are too
of great present importance, but their occurrence indicates
ce of a factor concerning which we are not yet informed,
, at some time, give us easier control of the insect. The
spread from infested nursery stock has been reduced to a
There are yet a few local growers of peach stock on a
, chiefly in the northern counties, who probably distribute

some infested trees; but they find it increasingly difficul of their stock. The dealers and growers that send stock State or receive it from outside points are keeping the clos watch on all their growings, and all the larger establish built fumigating houses. Some of them fumigate all sto as a matter of precaution, and some also fumigate to d plant lice and other pests as are often distributed wit plants. Others fumigate only when requested to do so, actual presence of some troublesome species makes it seen

I have previously noted the fact that Osage orange frequently infested, and I have again verified this as a sou infestation. The hedge plant itself seems not to suffer and that makes it a continuous menace to the surroundin

One thing seems now fairly certain, and that is that the a menace to our shade and forest trees. I have kept thi in view, and, even in sections where almost every fruit tr scale, the usual shade trees have remained exempt. A ro in an infested Osage orange hedge were completely free fr sect, though thousands of crawling larvæ were round abo been for some years.

As to methods of treatment, nothing new has devel crude petroleum is not only holding its own as the best agent, but its use is extending continually. Over 40, were used in New Jersey this past year, and over 1,000 g been used by individual growers. We have over half a fested trees in the State, and over half of them were during the winter of 1900–1901.

Whale-oil soap is used to a considerable extent for sum cations, and, more rarely, for winter work on peach.

The lime, sulphur and salt wash was used in Burling by one grower with excellent success. Similar good resu ported from Washington, by Mr. Marlatt, who explains usually long period of dry weather gave the insecticide a become effective. The New Jersey application probably lar opportunity, and it is reasonably certain that, could w a dry period of three weeks, we could make this Califor do equally good work here.

The chemical reactions are explained in Mr. Marlatt somewhat as follows: "The wash, as finally prepared, cont amount of calcium sulphid, some of the higher sulphids small amounts of calcium sulphite and a large amount

; also some of the excess of calcium or lime is in solu-
sidue is composed of lime.

wash were applied to trees in a dry climate, the various ormed would remain for a long time, and only gradually Eventually, however, the calcium sulphid would de- st likely forming calcium sulphate and some hydrogen S), and the calcium thiosulphate would decompose, first calcium sulphite, which last would oxidize to calcium he lime would change to calcium carbonate ($Ca\ C\ O_3$) ysulphid would break down, yielding sulphur and cal- l, which would, in turn, change as above.

climate the calcium sulphid and the calcium thiosul- soon leach out, leaving behind small amounts of cal- te and a large amount of lime, which would, in turn, le calcium carbonate. In this latter case the tree would white and appear to still have the wash upon it, but, in le other than the calcium carbonate would be left."*

s, briefly, that in dry climates the wash decomposes giving off suffocating and poisonous vapors, acting con- on the insects that are covered by it. In the presence these compounds simply dissolve out at once, leaving coating of ordinary whitewash.

rlatt's experiment, dry weather continued from March e of application, to April 11th, a period of eighteen effect of the wash upon the scales began to be noticed four days after the application, and increased continu- ter.

enefit of those who may wish to use this material, the mula used by Mr. Marlatt is given :

....	30 pounds.
....	30 "
....	15 "
....	60 gallons.

re was steam-boiled about four hours and applied hot. ndations as to the method of preparing the mixture vary ut the following seems indicated : Slake half the lime, ilphur and boil until thoroughly dissolved. Then slake

0, New Series, U. S. Dept. Agl., Div. of Ent., p. 35, note. The de by Mr. J. K. Haywood, of the Bureau of Chemistry, and reported Viley, Chief Chemist.

the balance of the lime, add the salt during the boil
solve it all, then combine the two mixtures and boil
hours longer.

It should be added that, in the vicinity of Freeho
Schanck, a commissioner under the State law, serve
tices to clean trees from scale, where infested trees
suspected to exist. This had the effect of arousing i
Schanck's report is that in almost every instance ow
trees responded readily when the situation was expla

SHADE TREE INSECTS.

A number of species that come naturally under th
been elsewhere referred to; but there are some oth
noticed.

The first of these is the *Elm-leaf beetle*, which has
from its temporary check, due to the epidemic disea
three years last past. The insects were very abunda
only at New Brunswick, but in other parts of the S
places the foliage was completely destroyed or so br
figured as to be an eyesore and of no use to the tree
admitted of a new start of foliage, and enough was
the trees safely into the winter. There was no trace
tial second brood of the beetle at New Brunswick;
foliage much eaten by the midsummer beetles;
seemed anxious to be out of the way as soon as po
little was seen of them. No change has been made
treatment, and nothing more reliable or effective tha
sprays has been discovered. The effort seems now
the direction of securing more effective machinery.

The Wood Leopard Moth is spreading slowly, but i
injurious as it has been in its older locations. Th
nearly so abundant at the electric lights in the citie
are not dying off as in the past. At New Brunsw
over the city, and I have found larvæ and pupæ i
branches blown down by high winds; but only a
come to my attention where young trees have been g

Maple-Leaf Stalk Borer.

eresting attack was reported on maple from South Or- the latter part of May. The complaint was that each t that time, certain maple trees began to drop their foli- this seemed to be due to the work of an insect. A eaves, sent in at my request, showed what was, appa- ll Coleopterous, or beetle larva, boring in the leaf stalk ; being made that, when the leaves dropped, the grubs that portion of the stalk which adhered to the tree. rly days of June I visited the grounds personally, and ge sugar maples badly infested. Both were in full foli- hy looking, but under them some 25 per cent. or more lay on the ground or had been raked up. From the made, it seems that the parent, which is assumed to be snout beetle, gnaws into the stalks of the most vigor- a little beyond its middle, and there lays an egg. The atches in due time, and begins to eat toward the twig, llowing out the leaf stalk. At the time that I saw the s than an inch had been excavated by the young larva. o not drop at once, and so long as there is plenty of no high wind they remain on the tree. When a dry on there is an insufficient supply of moisture for the roop, and finally fall to the ground, breaking off at the he egg was deposited.

son made two other visits to the infested trees to secure about the end of June the larvæ were full grown. They y one-fourth to three-eighths of an inch in length, and htly into the leaf stalk, which was now eaten to the tachment to the twig. A lot of them were put into a vith moist sand, and into this a large number of speci- themselves promptly ; but, instead of completing their ns, they decayed or dried up without exception. Each ll sand-covered cocoon or cell about an inch below the en remained quiescent until all were dead.

came certain that my larvæ would not develop, Mr. ght pupæ at South Orange, beneath the infested trees, ccess. The solution of this problem, then, must lay ther year.

Bag-Worms.

From all parts of the State came complaints of the ab
this insect. They began in May and continued until la
coming chiefly from cities, towns and villages, where Arb
other evergreen hedge and ornamental trees were victi
clair, the Oranges, Cranford, Madison and the territory s
Newark and Elizabeth brought a large part of these recor
doubtedly much real injury was done, because Arbor vita
pletely defoliated, is doomed. The season seemed to suit
exactly, and the increase late in summer was much grea
tionately, than in past years.

As to remedial measures, I advised hand-picking where
done, and the application of arsenate of lead where a sp
needed. A correspondent from Madison states that he
mond's slug shot with a bellows, and effectually disp
pest. It is probable that this material can be satisfacto
dry weather where the area to be treated is not too large.

In orchards the insect is well under control, because of
universal application of arsenical poisons for the destruct
insects. It is curious how far the caterpillars will wande
grown. In the Experiment Orchard there is one female
tip of one Keiffer tree, and I believe this is the only exa
place. The nearest point at which it could have been
over 200 feet away and outside the fence line.

An interesting experiment was made at Hammonton
spring. At this place the bag-worms had always been ser
rious to shade trees, hedges, etc., and they detracted mat
the appearance of the streets. At the request of some o
bers of the Council, I visited the town, and, after a cons
was agreed that Mr. A. Monfort, the Insect Commissione
State law, who was a resident there, should make a sys
spection, should see all the owners, and try to obtain the
tion in exterminating the pest. The governing body wa
erate also in any way that was feasible.

Mr. Monfort made his inspection, served printed no
necessary, and distributed copies of Circular No. 8, dealin
insect, with which I supplied him.

The result is reported as very satisfactory, and shows w
accomplished when a matter of this kind is energeticall
hand.

ORCHARD INSECTS.

ns and work in the Experiment Orchard were continued eason; but the records are not included in this report. ave now been under continuous observation since the 8, and many lessons have been learnt from them. Most ies and some of the pears began fruiting in 1900, and made a very decent crop in 1901. Some trees proved and four peach were cut down to make way for others. djustments being also necessary, it was decided to em- omplete records and their lessons in bulletin form. ly all of the original trees were scale-infested when set, not has been lost through the direct injury caused by this insect." They have had no better care than could be y man ordinarily attentive to his business; in fact, I t a commercial orchard to receive better care than I direction of controlling plant disease. Two peach trees ut this fall simply because, while they set heavily and it, every bit of it rotted before it ripened, and I got not e peach. The trees were scaly, and always had been; insect been alone concerned I would not have lost a ould have guaranteed a crop for 1902. In fact, none of were due to scale injury. In this little area I used eason of 1900 "Disparene," "Pyrox," Swift's Arsenate ammond's Thrip Juice, Rose-Leaf Tobacco Extract, 'Yankee Yellow," petroleum of various kinds, potas- le, and perhaps a few other materials that do not now

-There is always more or less trouble from this pest, but local at present. There does not yet appear to be any other such invasion as overran parts of Cumberland ears ago. Usually they are reported from gardens or on this year they seem to have taken a fancy to peach, eat- ge and fruit. From Glenwood they were reported in ndance late in June, as many as twenty-five examples one peach. Nothing more effective than collecting the umbrella or similar contrivance has yet been suggested.

Beetles.—A curious example of the occasional destruc- ce of an otherwise rare insect came from Atlantic county r some days the silky June beetle swarmed on fruit ing the foliage so as to leave bare twigs only. One re-

port was that the smaller shoots were actually bending loads of beetles. They are about half the size of the ord or May beetles, rather darker in general color, and with a silky, iridescent covering. In such a case there is not done, except gather the insects by jarring, and dump t kerosene pail. They do not ordinarily fly more than a and though they may devour a large portion of the fo present, the injury is not permanent. Yet it is altogether it will be years before they appear again in similar numbe

Plum Curculio.

The tax exacted by this species was unusually heavy. spondent from Monmouth county writes that if he knew value of the apple crop in Monmouth county he coul extent of the injury caused by the Curculio and Codling other words, just one half of the crop was destroyed. Fr saw myself, I think that rather a conservative estimate localities also; though of course, this percentage of loss do for the State at large.

Atlantic county always suffers severely from this insec year was no exception. A correspondent from Cologne in the summer that he had expected a heavy crop of pe had them actually on the trees; but so great was the *Curculio* punctures that the harvest was really very light. language in this case is interesting: "The Curculio has p season to be our most destructive insect. Owing to the and wet weather this spring, I, with many others, suppose not be active enough to be destructive, and no preventive were adopted. The result is that our apple crop is ruined—75 per cent. of plums and 90 per cent. of peache trees had all set well, and I expected several thousan This was reduced by the Curculio to about 200 baskets."

This correspondent has had San José scale on his place years, and the total loss suffered from this celebrated pe equaled a fraction of what the Curculio took this season!

Sinuate Pear Borer.

This miserable creature, while it has not been reported new localities, has held its own at New Brunswick, and I h

ægus, imported from France, in the course of my nursery ions. The latter point is of importance, since it empha- necessity of a close scrutiny of stock received from abroad n not strictly "fruit." Of course, all the infested plants lemned; but, unfortunately, in some instances the adult ged during the early summer.

Experiment Orchard almost all the older pears are now and in all probability new infestation has taken place. ts, at least, escaped from the trunks, and, as I saw several chard, I have no doubt that the old trees, referred to in reports, added their usual contribution. At the College rge proportion of the trees are infested—some very badly. n went over them all with a knife, early in the season, and rvæ and pupæ in great numbers—a dozen or more out of a , in some cases. He found that, with a little experience, difficult to locate the pupal cell by a slightly-discolored, ressed area in the bark at the end of the marks indicating g.

own trees I did no cutting, but tried to keep the beetles ng out by wrapping with strips of cotton sheeting about es wide, wound round so as to cover the trunk from the ll up into the branching. This was afterward drenched r and coated with cement and milk. The intention was to impenetrable coating, through which beetles could not When the wrappings were taken off, after mid-summer, it that two adults had made their way through the covering case, very close to the surface, through a single thickness g only. Evidently this sort of barrier is insufficient; but I again next year, with some stouter material. I cannot be at some beetles were not kept in. Tree No. 20, which was last year, had six full-grown larvæ, and the neighboring seemed as badly infested. That only two beetles should all the other trees argues some sort of check.

Pear Midge.

State at large and in well-cultivated orchards this insect is n nowadays. I found it last year on the first fruits in my nt Orchard, and destroyed the few infested pears. This a light set of Keiffers, almost every pear was taken. What e made a basket or two of fruit was reduced to less than a

dozen. This pest also is a contribution from a neighbo no attention to his trees, and it gives me another speci ment with. His trees are dying off, and so little fruit that the insects were forced to seek new breeding ground happened to be nearest by, and they got the crop. I pic destroyed infested fruit as fast as I saw it; but it is qu that some specimens escaped to bother me next year.

Incidentally, it may be noted that not an example o Golden Russet pears was attacked, though there was fruit on the two trees of this variety than on all the other

INSECTS ON FIELD CROPS.

Taking the State at large, the *Hessian Fly* has done li There have been some infested fields in the northern State, and, in a few instances, the crop has been reduced tent; but there has not been any reduction of the crop as a whole. This is due very largely to the fact that f learned to delay seeding just as long as they possibly little is done in the southern counties before October 1s in Hunterdon county the tendency is to hold off until even longer. At the Cornell Station, in New York, expe made with varieties of wheat, looking to the possibilit one that is "fly-proof." The results have been interes some extent, contradictory. First, it seems that the He done injury in that State amounting to nearly three mil lars; second, it seems that one variety of wheat—th stands out prominently from all others in that it is nearl Summing up, in Bulletin No. 194, Prof. Roberts says: ' is indisputable evidence from the Station Farm and fro farms located in four different counties of the State wh tive experiments were conducted, that Dawson's Golde almost perfectly resisted the attacks of the Hessian fl season of 1901 in New York State, and that no other v were compared have done so, although in a few cases, w and conditions were peculiarly favorable, No. 6 and ' have made fair to good crops."

It should be added, however, that in Canada, the h variety, it is not in any way exempt from fly attack. trary, so far as the records go, it is one of the poores standpoint. Other kinds have been found much more

ves, what has been suggested by others, that there is a n the behavior of identical varieties in different localities. refore, it will not be safe for the New Jersey farmer to son's Golden Chaff, with the idea of securing a wheat attacked, it may pay him to plant it, in comparison with s other varieties, to test its value under local conditions. is further suggested that farmers study their surroundings y than they have done heretofore, and, when they find a eat which, in a fly year, is little or not at all infested, let ain the reason for the exemption. It may be the date of may be the character of cultivation ; it may be the variety; be a combination of all or any two of these factors.

n is a white chaff, bald wheat. The grain is so light an it is sometimes classed as white. Heads rather short, mpact, and yields beyond its appearance when standing."

history of the Hessian fly, and the general methods to in controlling it, have been given in the bulletins and ne Station, and there is little to be added to what has been blished. What should be emphasized is, that proper farm ll go further to control the pest than anything else that e. One practical feature, which is at once the most effect- st generally resorted to, is to plant a decoy strip in early The object of this is to furnish a place which the flies lly select for oviposition. They will lay all their eggs dle of the month, if they get the opportunity; certainly end of the month, except in the case of long-continued This decoy strip can be plowed under deeply, at the time rop is planted ; or, if it is on another piece of land, the n be delayed until the main crop makes its appearance nd. Another important point is the thorough prepara- seed-bed and careful seeding; in other words, give the y possible chance to make a vigorous growth, and the ill be to resist the attacks of the insects, even if made. ter, of Ohio, who has studied the Hessian fly for fifteen uoted as saying that he believes that four-fifths of its be prevented by a better system of agriculture.

nnection, the following from a "Winter Wheat" Bulletin nessee Station is suggestive: "The fertilizer plats were not affected by the fly—the best argument that can be show the importance of having the land in excellent con- well supplied with plant food. It is hard, on any other

basis, to understand why the fly should attack some of
in contiguous portions of the field, and injure them qu
and have apparently no effect on the fertilizer ranges."

Angoumois Grain Moth.

After the report for 1900 was prepared, complaint
numerous and requests for information so urgent that
report could not get into the hands of the farmers in
immediate service, it was decided to publish a bulleti
distribution. This was handed in December 10th, and s
in the new year as Bulletin No. 147. In it was given a
of the history of the insect in our State and a full desc
life cycle, as an explanation for the detailed directions c
destruction or control. The main point emphasized was
ing should be done as soon after harvest as possible an
grain should be bulked or sacked. During the season
suggestion was largely followed, and, up to the time of v
rial damage has been reported from a few localities onl
insect is yet doing mischief is proved by cases where gr
be at once attended to. This was found to be infested
ined in stack or in shock, and here and there some in
noted in the bins on the upper surface. The tendenc
either market or mill as soon as possible, and where
absolutely necessary sacking was generally resorted to.

In parts of Gloucester county, reports says, less whe
has been planted because of the danger from this insec
be that some Burlington county farmers have felt the sa
in determining the extent of their wheat area.

It is also probable that some millers, who have b
apparently sound and placed it in bins, will yet lose s
is promptly worked up.

An encouraging feature is the occurrence of a larg
parasites in every infested sample received. A few yea
this moth became destructive, the appearance of this p
in number marked the end of the invasion. It is no
that it will do so in this case as well; but natural forces
are at work against it.

INSECTS ON TRUCK CROPS.

b *Beetles.*—It is not often that rhubarb suffers from insect , if it does, the growers do not complain; but there is a ıich, in the larval state, bores into the stalks and unfits them et. It is not a new species; its habits and general life ıve been long known, but, up to the present, there has been of trouble in this State. This year (1901) it made itself three different points, and it may be well to indicate the ne of treatment. This is simply to cut close throughout the king all the older leaves, even if they cannot be marketed. persistently done no larvæ can come to maturity, and the 's crop of insects will be disposed of in advance.

gus Beetles.—These insects have not been especially trouble-ing the past season; they are always present, and both ere observed throughout the region where this crop is ; but no serious injury was caused. The only complaint t the office was that they were defoliating the ornamental variety of this plant.

Beetles.—Locally, these insects attracted attention on sweet but were hardly more troublesome than usual. The vines, the weather, got a good start in the spring and outgrew s rapidly. From Vineland a new form was added to our e "Argus" tortoise beetle—the *Chelymorpha argus* of the gist—and this is much larger than those more usually found nvolvuli, to which the sweet potato belongs. The normal is new pest is the sunflower, and, probably, the attack on is simply a local aberration. If not, and it should threaten e treatment is the same as for the other species of this

: sweet-potato insect attacks the plants in the forcing-bed. ent me from Salem county showed masses of mealy bugs at the bases of the sprouts and of the small leaves. I have at these creatures will survive the normal outdoor condi-n the plants are set out in spring; but they undoubtedly growth of the shoot and make a weakling plant if it is set. prevalent the insect is I do not know; but, where it occurs, s or store-rooms should be thoroughly whitewashed and fore the seed potatoes are stored. The temperature should low as is safe, and the bed in which the roots are forced

in spring should be entirely clean. It may be also well the roots carefully before putting them in, and to reject show the insect to be obviously present.

Potato Beetle.—In the extracts from the Crop Bulletin will be found referred to at some length. It has been in previous reports that the insects have been rather broa their bill of fare, including tomatoes, eggplants and other useful *Solanaceæ.* This season they have extended their r *Cruciferæ,* and have attacked turnip tops, in destructive n Atlantic county.

AN INJURIOUS ROOT CHAFER.

A curious phenomenon was the abnormal increase of smaller leaf-horned beetles or chafers, known as *Ligyr* This is smaller, chunkier and more roughly sculpturec ordinary June bug or May beetle, to which it is otherw It is always common along shore, where it is a nuisance at this year seems to have extended throughout the State in numbers. For several evenings walking was unpleasant b arc lights at New Brunswick, owing to the number of th covering the walks. It was impossible to step without cr or more, and the examples still on the wing struck han in their blundering flight.

Never before had this been reported to me as an injuri but now it is at hand from several points as a root-feeder. serious trouble was reported from the Dreer nurseries, at where it attacked and fed upon the roots of hardy Pyretl was remembered then that about three years ago they wer at the roots of the hardy varieties of sunflowers.

Bearing on the same point, but just a little beyond our complaint came from Torresdale, Pennsylvania, that an of sunflowers had been destroyed and a bed of Cosmos att

The larva is a white grub and feeds on decaying vegetabl principally rotten wood. What peculiar combination stances resulted in this abnormal abundance I canno there is no reason to expect any similar increase next yea

CRANBERRY INSECTS.

material point left incomplete in my previous study of affecting this crop was the life history of the katydid, that e berries and devours the seeds. This has been a sore veral years past; but it has seemed impossible for me to ogs at just the right time. All the other pests are fairly ol, and the methods of dealing with them are well un- out "grasshoppers" have each year demanded a serious has seemed impossible to get at them. This past sum- mined to make the completion of this study an "impera- with the co-operation of Mr. Joseph J. White, of New egg-laying habits of the species were successfully deter- owers may now act intelligently toward the destruction , and, fortunately, at a season and in a manner that gives nity for thorough work. A full record of what has been rs elsewhere in this report.

MOSQUITOES.

quito problem is attracting attention wherever the pest since a definite relation between the insect and malarial been established, it has become important from a new w.

med to me that a study of this question, so far as it af- te, was of importance to its agricultural interests, because doubt that the abundance of the species near the shore in other parts of the State prevents that growth of popu- would otherwise furnish a local market for much of the in the State.

this report is devoted to a statement of the investiga- the results attained, and the work that yet remains to be

ated, the mosquito pest can be reduced by 50 to 75 per rmanent works, that will be useful in other directions and done by the State. Of the remaining 25—50 per cent., 10 per cent. can be destroyed by municipal or individual will require an appropriation of at least $10,000 to make nsive survey and formulate a plan looking to the end it.

INSECTICIDE COMPOUNDS.

A number of insecticide samples were sent in durin and some were tested in the Experiment Orchard. Th not material where the results were negative or inconcl not always fair to condemn upon the results of a sin experience, and mere mention will be made of such case the work done and the results aimed at.

Arsenate of Lead.—This was used on the foliage of o of all kinds, and very strong—about one 1 pound in water. Not even peach foliage suffered in the least, w application not a brood of the web-worm developed c Rose plants infested with slugs were also sprayed and gave away several parcels to neighbors, and in every c work was done, without harm of any kind to foliage applications were of much greater strength than reall and traces of the material remained for months afterw trunks and branches—indeed, after all foliage was go object was to find whether this was something which necessary to employ carefully for fear of injury to plan samples were used—one made by the Bowker Fertilize of Boston, Mass., and sold under the name "Disparene by Wm. H. Swift & Co., also of Boston, and sold as Sw ate of Lead. Both are in the form of a white paste, readily with water and remains well in suspension. At at which these mixtures were employed by me there w ence between them, and both are good.

The advantages of this material are its absolute safe plants are concerned, effectiveness when used proper preparation and lasting qualities. It is the only form that can be safely applied on evergreens, and for gar growers on small areas it is the ideal insecticide against species. At present prices, the prepared forms are too e the orchardist, and Paris green or green arsenoid are factory.

It was intended to make comparative tests of the las materials and other arsenical mixtures by spraying elm-leaf beetles. But the date of the spraying period coi closely with a spell of intense heat, and, somehow, possible for me to find the college janitors who were to d until it was too late to make the applications.

l Soap, with and without the addition of tobacco extract, l to kill plant lice, leaf-hoppers and larval scales, in each xcellent success. The material used was made by James hiladelphia, and left little to be desired. A somewhat ed reference to this material will be found elsewhere.

'xtract (Rose Leaf) was used against plant lice and leaf-h fairly good results. It did not stick so well as the es in orchard use and did not so readily wet the insects.

Yellow," a combination of arsenic and sulphur, was lly used with negative results. Theoretically, its com-ould make it an ideal insecticide and fungicide, but, n practice, the results were unsatisfactory. Yet the deserving of further tests, and, if possible, experiments ed on next year.

combination insecticide and fungicide prepared by the tilizer Company, was used on peach trees to check fruit most disastrous results. Foliage and fruit were both the application was thoroughly made, and no corre-dvantage was secured on the remaining fruit. Yet this ndemn the material for use on other trees, for the peach ly a sensitive subject.

's Thrip Juice was applied according to directions against eaf-hopper, with a fair measure of success, but makes an nixture compared with the whale-oil soap or tobacco ex-harm was caused to foliage by the application, nor did it ee-hoppers to any extent.

soluble carbolic acid preparation which was tried against eaf-hoppers and scale larvæ on currant, grape and apple. was unsatisfactory and inconclusive. The effect on the not well marked, while the effect on the foliage, of grape was disagreeably obvious. Based upon my experience, t a promising insecticide.

—This was used altogether as a winter application on all y orchard fruit trees, with results that are elsewhere re-hree made-up petroleum combinations were also tested, lly unsatisfactory results. Several hundred thousand eated with the crude oil during the winter of 1900–1901, not be long before the range of usefulness of this material ablished.

hese specifically named, a few other soaps and special

combinations were tried, but the results are not satisfactory interference spoiled some of the tests, and, altogether, it is to let specific reference lie over until a fairer trial is possib

Whale-Oil Soap.

This has not, for some reason, proved successful as a wi cation against the San José scale in New Jersey; almost using it reported partial or total failure. One correspond an orchard of plum trees, thoroughly sprayed during the apparently well cleared in spring, to be so badly re-infested as to seriously impair the value of a heavy crop of fruit. were swarming in such numbers as to make treatment, as fruit was off, an absolute necessity. But, on the other h are not wanting reports of excellent results following per

For summer work the material is excellent, and I have u potash soap with satisfactory results, against plant lice scales. For plant lice, indeed, I know of nothing better. a large scale, against the pea-louse, is elsewhere recorded apple plant lice I found it effective in the experiment or reasonably so against grape leaf-hoppers.

Late in the season I sprayed several trees with about 1 gallons of water, to check San José scale breeding, with effect. It cleared out all the active larvæ and many recent had no effect on older insects nor upon the breeders; but not expected there was no disappointment. It did not ha even on peach. Altogether the material has proved so us proper supply seems necessary on any farm where plant kind, or scale larvæ, must be fought.

An experiment made in Atlantic county shows that an of 1 pound in 1 gallon of water, made September 21st, w rose scale wherever it is brought into contact with it. A strength it is practically ineffective. The stronger mixture the plants; but, at that season, this merely hastened, with the normal foliage. The buds, in all examined cases, sound.

Crude Petroleum.

This material is now the chief reliance for fighting th scale in New Jersey, and our farmers are learning grad best to use it.

22d, Mr. W. P. Cutler, of the Atlantic Refining Comned me that they had sold 795 barrels of crude oil for uit trees in the State of New Jersey, during the winter 1900–1901. Over 100 barrels were sold by two other nto this State, and there is no doubt that over 800 barctually used by our farmers. A considerable quantity rchased from dealers who did not specify the purpose for s purchased, and of which, therefore, the selling como specific record. This means, certainly, forty thousand llons of oil used, and, at an average of one pint per tree, mall, diluted or undiluted, would mean three hundred thousand (320,000) trees sprayed! It will be quite he figure at 250,000.

seem as if this was a sufficient number upon which to judgment as to the value and effectiveness of crude oil. em also that, if it were really dangerous, a large percenteated trees should have been destroyed, or at least mated. Yet the reports that have come in from those that t certainly do not bear out the idea that any great harm

e latest records comes from a prominent fruit grower in ounty, dated October 10th. He used twenty barrels of ostly on pear, though some peach trees were also treated, tisfactory results. The oil was used soon after the holivas applied undiluted. Not a single tree was injured, date of writing, the trees were as green as in midsummer. ned to give them a new vigor. "Where we sprayed last aw scarcely any scale, but where we sprayed a year ago ve had considerable scale on the fruit; so I have come to on that we will have to spray every two years. I am t we can control the scale, but will not get rid of it. I it as much as I do the Codling Moth, for we have to r three times each year, and sometimes it will get the On this farm the oil has been used for three years, and oint has hurt nothing. Of course, the owner is a careful ealizes fully what he is doing, and the applications are his personal supervision. He is also a successful grower, fruit growing pay; so his utterances are those of a pracd not a theorist.

qual to this have been obtained by other fruit growers rds I have seen, and of pear trees I do not believe a

single one has been injured. Apples have not been so
Some varieties seem to be quite susceptible to injury, and
several records of trees severely injured, or even killed,
application was made too liberally. Yet, as will appear l
varieties will stand the most thorough application poss
plums the applications seem to have been unusually satisfa

A Gloucester county plum grower sprayed all his trees
oil during the winter, and, in fact, has used the oil for
He harvested an immense crop of plums this year, all in
condition, and his report, late in August, was that: "Wh
oil came in contact with the scale it is completely dest
should have used a double nozzle, but, being timid, I used
The extra application I gave some of the trees has removed
my experience has taught me to be more careful in coveri

The "Rural New Yorker," of June 29th, 1901, contains
of applications made to Abundance, Satsuma and Bail
plums, on the Rural Grounds, in March. The stateme
these trees have now the darkest and most luxuriant folia
"We do not think the oil can add anything to the vig
trees; but the thorough applications we gave, going over
twice, have not only exterminated the scales, but surely r
buried beyond all resuscitation any fungous spores that adh
bark, as the surface is still coated with paraffine, which wi
according to previous experiences, until late next sprin
suggestion is made that this application may really have ha
erable effect as a fungicide, and may account for the genera
condition of the sprayed trees, as compared with others of
varieties that were not treated.

On September 4th, the same journal published a summa
years' trial of crude petroleum. Eleven young fruit tr
cleared of scales, and remained clean for one season. In
scale appeared in midsummer, after a spraying in Marc
trees were cleared of scale, and remained clean for two
years. One tree remained clean one year, but showed re-i
the second. "The failure to clear out scales the first seas
a good-sized Satsuma plum tree, headed back to get rid
branches. The tree was sprayed carefully late in March,
and foggy weather evidently prevented the oil from sticking
June brood spread over the unprotected areas, but has not
foothold on the greasy surfaces." A good suggestion occu
end of the note: "The difficulty of thoroughly spraying l

ident on trial, and the final outcome, unless totally new relief are discovered, is likely to be a demand for low- earlier-bearing varieties."

trees the oil has been generally successful, but there is aint of injury. More peach tree treatments were made fore, not only in this State but also in Ohio. From the [have general reports only, and they are favorable. In Island district, 200 barrels were used of the high-grade e of a lower grade. It was used diluted and undiluted, is reported for both methods. A heavy oil was used in is, and seems to be favored by some when a 20 to 25 per e is to be employed.

rdon county, Mr. Fred. B. Sutton, of New Germantown, able commercial spraying—that is, he contracted to spray others who did not have the machinery, or who preferred work done. In answer to my request for suggestions of iature, based upon his experience, he writes as follows: in yours of the 18th, what, in my opinion, are the proper bserved in working the Kerowater pump. In the Dem- ds Kerowater the only rule I would suggest is—not work Oil and water are so averse to mixing that an accurate each cannot be coaxed out with one pump with two suc- nd a valve on the oil suction. In the Goulds Kerowater holds, say, 6 gallons, and the water barrel around it, each is filled and the pump set to pump *over 12 per* oil-tank should empty first. Anyone not acquainted sult would likely pump so long as any oil comes out of then they shut off the cocks with more or less compressed chamber of each pump This is wrong. Pumping after w the suction in the oil-tank allows water to work over imp or tank, and, when the valves are not perfectly tight ump, the compressed air forces water from the larger hamber until quite some water may be found in the oil- etimes, too, the water compartment is filled to the top, will splash a little more in. Then someone spills a little ng.

ter where it is put it in, it all goes to the bottom, and arted again, why, the darned old thing pumps all water. hat else could it pump, when both suctions are in water, pump being so much smaller and so far behind, is quite

a while catching up. It's got all that length of hose an
to run, too."

"Now, in the first place, both pumps must be kept
and on equal footing with each other, because one is wor
the other, and if either slips it can't do its share. The
should be stopped before the oil gets quite out, and th
be left open, to let the compressed air out, so that the
not be pushing against each other while filling. Ther
the water-tank too full and the pumps will be much
people's liking."

In another communication, Mr. Sutton, in speaking
done in his vicinity, speaks as follows: "As to the
spraying oil, I think most of the orchards sprayed ha
proved, but many have had such poor work done that
gained. The 25 per cent. spraying is, without doubt, s
ter now than the undiluted applications, and most ever
favoring it. The other may last longer and be best;
seen more good on peach with 25 per cent. I think cl
strong for the peach tree. Either, well done, will keep
check, and that is all we may expect; but what is best
I think the March spraying is looking best, too, and ther
left to kill what was at first missed than where sprayi
earlier."

These suggestions are important and should be taken
eration by those who find it necessary to use the oil.

The experience that I have gained has led me to c
little my views on the desirability of undiluted applicat
think that using the high-grade oil undiluted is best wh
is properly and intelligently done. It is in this way
used, and shall continue to use, it whenever I find it nec
average workman, however, is likely to lose sight of th
of careful work at times, and under such conditions p
per cent. mixture would answer better. If this perce
used, it will also be possible to use a heavier oil, wh
cheaper. The heavier oil is, in fact, deemed better by s
of the greater paraffine content; it leaves a thicker
longer time. In other respects, I have no change to
suggestions as to using crude oil. Fruit growers are co
with more confidence and better judgment, and machin
ing better adapted for the work. The Gould Kerowat
best American pump for spraying a mechanical mixture

ndon, Ontario, and called the "Spramotor," has been Ohio growers and by some in Canada. This, too, has satisfactory, and in some respects may be even better ld pump. At all events, there are two good machines t, and, as the quality of the oil for the mechanical mix- important, it may be safer to use this.

pplications have been on the Experiment Orchard only, em have been of oil undiluted. Only one record is here 30 is a Grimes Golden Pippin. It had been sprayed in eived no treatment in 1899. In the latter part of that ales found their way on the tree, and during 1900 it be- dly infested indeed. The bark when cut showed the purplish-red, absolutely unhealthy, and the red stain the wood. I do not think I ever saw a much worse- than this was when winter finally set in and the scales ling. I determined, therefore, to give the most excessive ssible, to test the effect of oil in large quantity upon a d by scale attack. During the first days of January I urs painting the tree from the tip to the surface of the e oil was applied with a brush, by holding it to the end l simply letting it run down. The top of the tree was an eight-foot ladder, and it was necessary to bend gest shoots. In this way every part of the tree received as would possibly stay on it. It was allowed simply from the tips. The crotches had a very heavy appli- so did the larger branches, which received oil from ller ones coming from it. The trunk was treated e way, and the oil allowed to run as far as it nd underground. By the middle of January I had done for the tree completely. The oil was of the that I brought with me from West Virginia. The g over the surface was dense, and whenever there was in the air the tree presented a curious sight, owing to of water standing over its entire surface. On cutting hoots it seemed as if the oil and the stain from the scale to simply soak the wood. It was wet clear through. ooked as if bound to die. Wherever I tried the knife ce was the same, and I concluded that I had done the ne without any doubt. But as spring approached the to improve in appearance; a few twigs did shrivel up the others began to plump out. When I pruned the

orchard I cut this tree back a little more, in some direc would ordinarily have done—but, on the other hand, al many more small shoots to stand in the center. Muc prise the tree started—though a little later than norm started but grew and grew well, and has continued to g out the season. There was absolutely no loss in the tre that should have remained, and during the entire seasc was to be seen anywhere on it. Traces of the oil re October, and some parts of the trunk still had then a va that could be scraped with the fingers. Soon after growtl the coating of scale began to flake off, and in Octobe branches were absolutely clean and fresh-looking. I dc would have been possible to put more oil than I did on more would remain on—and if any oil application could it should certainly be dead by this time.

It was suggested, in a previous report on this subjec bly a made-up material, consisting of the light oils without any vaseline, might make a better material th oil. Some of the Ohio growers induced the Sun Oil Toledo, Ohio, to make up some samples, and of the four specimens. No. 1, a straight crude, sp. gr. 44.5 light amber oil, with a very pungent odor of naph marked partly refined, sp. gr. 44.5°, was said to have and burning oils out and to retain the naphthas and pa was the thinnest of the mixtures and spread better tl luted crude. It instantly soaked everything that it t 3 was the same as No. 2, but heavier, the sp. gr. bei was also very fluid at a moderate temperature; but, formed a surface film before I was through, and a su formed in the can. No. 4 was yet heavier, having a sp. This spread less rapidly than any other, and thickene exposure to the air; in fact, what was left in the cup that it would not pour back into the can, but had to with the brush. The application was made Februar bright, clear day—sunny and warm—in the sun. Th on the ground, and in the sunshine this was thawi Trees 1, 28 and 29, representing plum, peach and ap for the experiment, and each tree had one branch pain of the samples. In other words, four branches on e treated, each with a different mixture, and all were t day I found that sample No. 2 had extended down a

w the point reached by the brush. On tree 28 it had n the trunk fully 15 inches, and for a space of four aked all around the trunk. This sample has much the ding power. The undiluted crude was greasier in ap- n any of the others, and sample No. 4 had the dullest Sample 2 was driest of all; but even here a greasy oduced on rubbing.

sult of this experiment was that samples 3 and 4 killed to which they were applied. Sample 2 did some in- nple 1 did no harm at all. The applications were all ntity. Sample 4 could not be used in weather that freezing point; in fact, it is doubtful whether it could n the thermometer at 40°. Sample 3 was better and ly be used at the latter temperature. Sample 2 could used whenever the crude oil itself could be employed; find that it would be as safe.

eemed necessary to collate results obtained by other ex- n other parts of the country; some are good and some me find the undiluted oil harmful, but the 20 per cent. safe and effective. For the conditions as they exist in [consider the crude petroleum much the best material st the pernicious scale. If used undiluted, a high-grade igent care are necessary in making the application. If echanical mixture, a lower-grade oil may be used, and vill be sufficient. In this case, the spray pump must be get uniform results, and the suggestions made by Mr. d be followed.

ime of making the application, it seems indicated that delayed until after midwinter. The ideal period for ist when the sap begins to rise; but as there may be a iitable weather at that time, it is best to begin earlier, ry in South Jersey and the middle of March in the nties would probably be nearly right as beginning dates. vait until after January 1st.

NEW BENEFICIAL INSECTS.

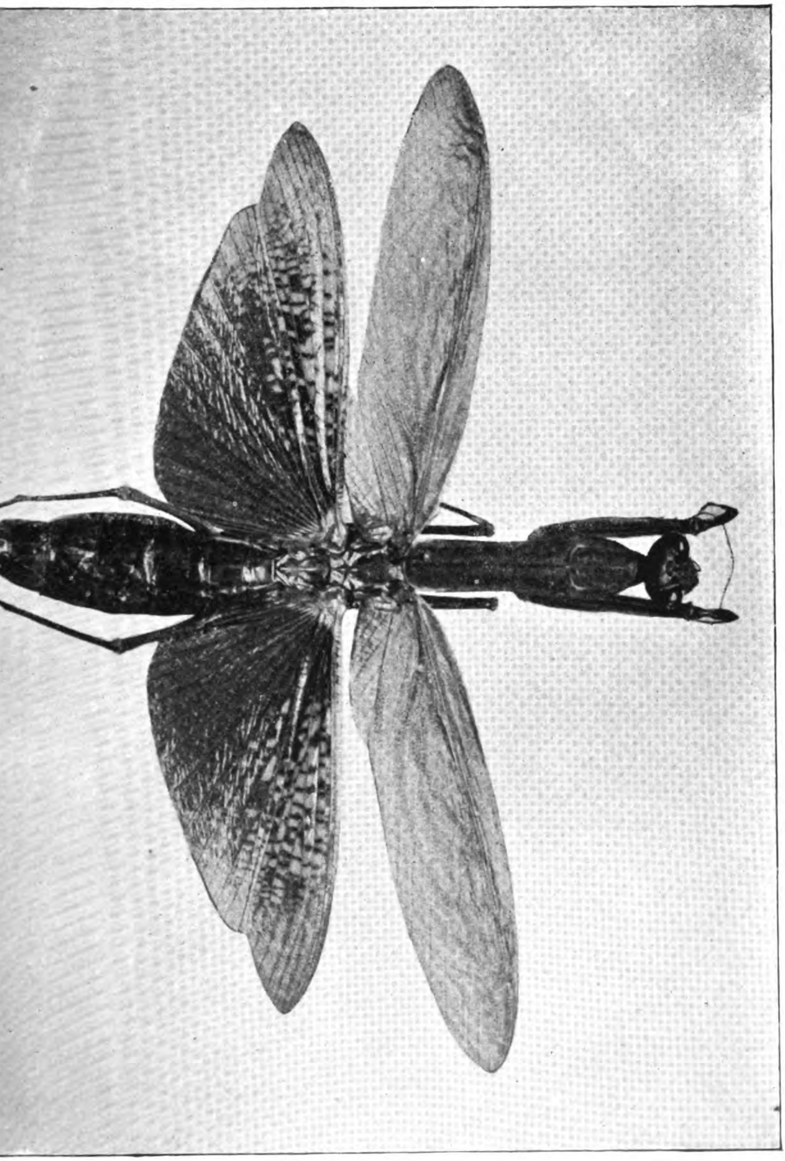
ne, 1898, number of the "Entomological News," pub- American Entomological Society in Philadelphia, Mr. nt recorded the capture, near Germantown, Pennsylva- e and striking Chinese insect, belonging to the Raptorial

family of the *Orthoptera*, or straight-winged insects. Tl came from the Meehan nurseries, and was accepted as a importation—which it undoubtedly was. In the yea more were found, and in the winter egg masses were see indicating that the insect had become established and wa Plate iii., herewith given, is a duplication of Plate IX., Vol. IX., and gives a fair representation of the insect, a size.

The family *Mantidæ* is of small extent in the order wh such pests as roaches, grasshoppers, crickets and the like from all its fellows in that it is predatory and carniv habits, feeding upon a great variety of other insects. N but the individuals are extremely voracious, requiring enormous amount of food to bring them to maturity. rence, then, of this Chinese species, at Germantown, P was matter for congratulation, rather than otherwise. reasonable doubt that an egg mass, coming on or with a Asiatic plants to the nursery, escaped notice, and hatche mens that found themselves able to survive.

I had kept rather a close watch on the species since was first reported, and, when it seemed certain that i domesticated, I asked Mr. Laurent to secure for me, dur ter of 1900–1901, a number of the egg masses for intro New Jersey. He very kindly agreed, and sent about early in May. These were divided into six approxin parts, and distributed, one part each, to Mr. John Repp Mr. J. Lawrence Lippincott, Riverton; Mr. Horace Rob town; Mr. N. P. Creeley, Burlington, and Mr. Henry logne. The sixth lot was retained by myself. All th referred to acknowledged receipt of the sendings, and d they had complied with the terms of my request. Mr placed them on apple, pear, cherry and currant, tying o in accordance with directions, as, indeed, did all the o referred to.

Mr. Roberts distributed the clusters, somewhat widely, of orchard and small fruits; Mr. Creeley put them on cu berry, cherry, quince, pear and apple trees; Mr. Lip them on trees in a row across the orchard (apple and pe Pfeiffer put them on apple, pear, peach, plum, curran berry. The lot retained by myself went, mostly, into th



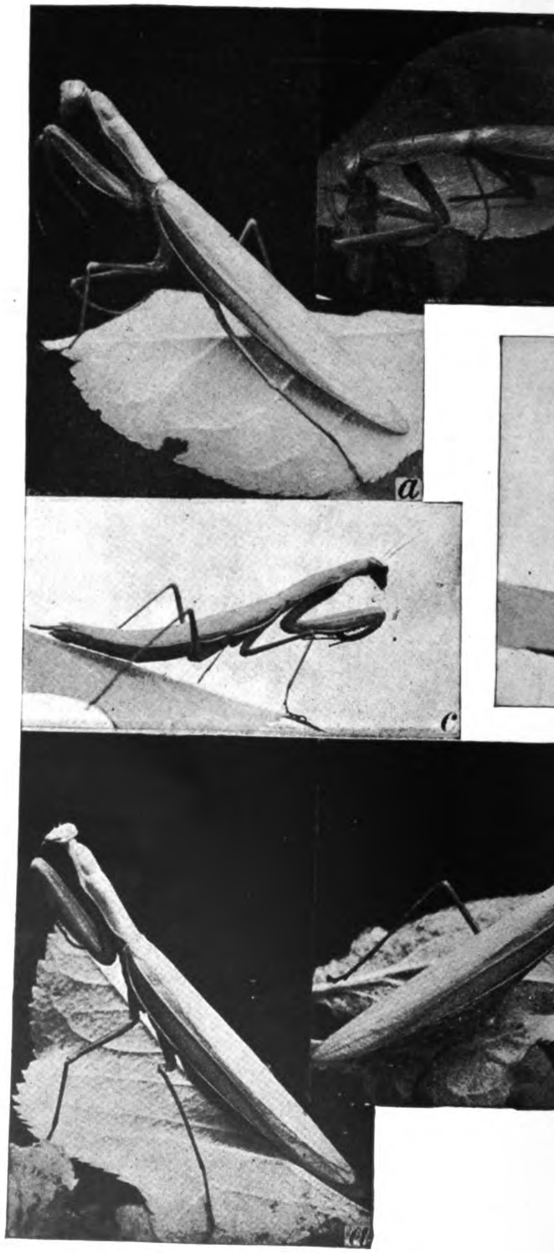


Fig. 4.

The praying Mantis (*Mantis religiosa*), *aa*, adult in waiting pos
adults eating grasshoppers ; *cc*, larval forms awaiting prey ; all natural
185, Cornell Exper. Sta.)

though some were tried on the fruit trees of a neighbor's

ember, 1900, Prof. M. V. Slingerland, Entomologist to the xperiment Station, published Bulletin No. 185, containing nt of the European "Praying Mantis"—*Mantis religiosa* ich had become established in the vicinity of Rochester, k. It seems to have made itself fully at home there, and erland kindly secured for me a lot of egg masses, that I empt to establish the insect in New Jersey. Unfortunately, roportion of these masses were not sound, and contained only. Some were, apparently, of the previous season, and were empty; others contained parasites, or predatory forms, e were destroyed at once. The balance was divided into all lots, of which one went to Riverton, a second to the 'arm, and the third was distributed in the Experiment The illustrations of this species are from the New York above cited.

The Result.

gentlemen receiving eggs, of either species, report that they nothing resembling insects such as I described to them; egg masses returned to me contained empty shells only.

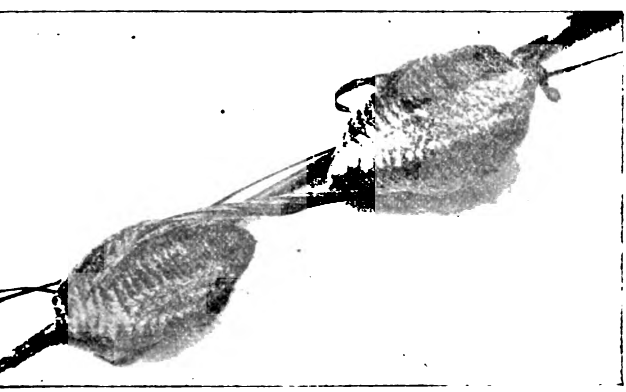


Fig. 5.
Egg cases of *Mantis religiosa* on grass, from Rochester, N. Y. (From Slingerland, Bull. 185, Cornell Exper. Sta.)

wn garden I saw immature examples on several occasions he summer, and late in August a fully-developed female of *sinensis* was captured in a neighbor's garden, and its life was

begged from the neighbor's boy. A second example w
late in September, and also released. It is probable tha
ture forms seen were of the same species as the adult;
were not captured, and slipped out of sight between the
grapevine, this cannot be certainly declared.

It is not improbable that though none of the insect
noted at the other points where eggs were placed, the
established themselves, and may make themselves m
next season. The effort to domesticate them in the S
continued if egg masses can be obtained.*

Results Aimed At.

The general object to be gained is the addition of an
to the rather scant army of predatory insects found in
or, better, to the predatory types, able to feed on injur
These Mantids are creatures of that type; they are alw
and find a congenial home in gardens and orchards, devo
thing that crosses their path, that is not capable of devo
As they are over two inches in length when mature
insects, if any, can master them.

No possible harm will result, so far as can be foreseen
of vegetation is eaten. No ally is threatened seriously,
no direct observations have been made, there is some
the earlier stages they may feed on scale insects.

More specific information concerning the life history
of these species may be deferred until their establishm
certain.

A Natural Introduction.

During the early part of October a male specimen of
was received from Mr. Hiram T. Jones, of Elizabeth, an
be either an original importation on stock from Japan, a
believes, or may have come from some stock received ind
Mr. Meehan two or three years ago. If the latter, there
that the insect will be found in Ohio in the near future,
stock suspected of bringing it in came through that State

* During the winter of 1901–'02 several egg masses were found in
Experiment Orchard—one about 1,000 feet away; so there was not c
but a reproduction.

MISCELLANEOUS.

espondence of the office during the year 1901 is contained ages of letter-book, representing above 2,500 separate com-is; and this does not include the circular letters sent to nur-ommissioners or secretaries of the boards of health within

stitute meetings were attended and five county board or ngs, for each of which an address on some entomological repared. A report was made to the State Board of Agri-the work done as State Entomologist, and an illustrated delivered at its annual meeting, detailing some of the ny trip to European institutions.

No. 147, on "The Angoumois Grain-Moth," and No. 149, Strawberry Pests," were issued since the last report, and distributed. A circular was prepared warning fruit grow-probable appearance of a brood of the Periodical Cicada d this was sent out with Bulletin No. 153. An index to r names used in the list of insects found in New Jersey ed for and published by the State Board of Agriculture, is believed, will increase the general usefulness of the

ontinued my attendance at the meetings of the Entomo-ieties at Newark, Philadelphia, Brooklyn and New York, received from the members assistance in the form of and information whenever desired. I consider it an o be in touch with so many working Entomologists and and it gives me unusual resources in securing reliable and material from a number of points. Credit is spe-ven for individual contributions wherever they occur.

edgment is also due to Dr. L. O. Howard and his staff of t the United States Department of Agriculture and United onal Museum for information and other courtesies.

omologist.—The work done in my capacity as State Ento-as supplemented the work of my department in the d has been almost altogether in the line of controlling the spread of injurious insects. The San José scale was ed at, but the work has really resulted in the destruction quite a number of other species.

s are now under control, and it is believed that stock more ving insect pests than that which most of our nurserymen

send out will be difficult to find. A closer supervisio
before is exercised by the nurseryman himself, which
receipt by him of clean stock and the sending out of simi
to the purchaser. Inspection of infested orchards was
request of individuals and advice was given to suit e
ditions. In fact, the general line of work was the sam
year previous.

The Collection.—The collection of the department has
tinuously and much of the material has been put into
shape during the past year. Several cases illustrating
forest insects are made up from specimens sent in by M
Brakeley from Lahaway, Ocean county, during a perio
over two or three years. Some of this is unique in c
unequaled in extent. An abundance of other materia
arrangement, and fifty drawer cases were added during
that purpose.

The special collection of the laté Dr. George D. Huls
lyn, N. Y., is now also in charge of this department, a
partially arranged. This is an exceedingly valuable ad
resenting, as it does, the life-work of the donor and cont
of the original types of the species named by him.

Assistance.—During most of the year I have had the
Mr. E. L. Dickerson, Class of 1902 S., for such periods
spare from his studies. During the summer he spen
months of July and August with me, and was of materi
in the office work. He did also some of the prelimina
work in orchards and nurseries, materially facilitatin
work.

Pan-American Exhibit.—The department, as such, wa
sented at the Buffalo Exposition; but some 30 cases,
injurious insects and their work, formed part of the ex
State Board of Agriculture and of the Forestry Exhibit
Museum. These cases were prepared at the request of
Morse, Curator of the Museum, and were used to illus
exhibits above mentioned. It was the object, in arr
cases, to illustrate all stages as well as the injury cause
of them represent several years of study and collectin
now accessible to the general public in the halls of the Sta

Haseltine's Insect Trap.—This is a large and deep tin
center of which is fixed a lamp, or torch, the light fr
reflected by two tin sheets crossed at right angles in the

* Gold medals were awarded to these collections.

d with water, which is covered with a scum of oil, and into ects fall when attracted by the light. For certain purposes may be a good one; but so sweeping and wild are the le for the contrivance, and so reprehensible and dishonest ls of the persons advertising it, that it seems well to caution purchasers not to expect too much from it.

sects are readily attracted to light. For others it has no whatever. Among the forms attracted are some injurious beneficial or useful forms. Among the forms not attracted at majority of all species, including some of the most inju- sects of the first series will be undoubtedly caught, to some the traps; others will not. To rely upon the trap alone, ard, would be suicidal, for the plum curculio and the th do not, either of them, come to light at all freely. I ubt the trap will show up hundreds of insects, at favorable at least half of these will be predatory, parasitic or innox- which are better alive than dead.

INSECTS IN THE CROP BULLETIN.

José Scale has the honor of being the first species referred rop Bulletin of April 30th—the first issue of the season. orted as doing great damage to fruit trees, particularly Franklin Park, Middlesex county, and much spraying with as done. At Hammonton, Atlantic county, many peaches ed as having been killed by the scale. June 4th, some oted on pear at Trenton Junction, Mercer county. June de use of the Bulletin to advise growers to be in readiness r work as soon as breeding should be observed, and this ve had the effect of shutting off complaints; at all events, rther was heard of it.

rpillars were first noted May 14th, at Rowlands Mills, Hun- nty, in small numbers. June 11th, they were numerous od, Hunterdon county; June 18th, the same report came n View, Cape May county; July 9th, they were marked troublesome at Hazlet, Monmouth county, and I suspect s time the "tent caterpillar" was really the fall web- which all further records under this general head must be At Burlington, Burlington county, they were so numerous rs were "compelled to stop harvest and spray to check es;" July 16th, they were so numerous as to cause grapes

to fall off; July 23d, they were again reported, and on the Harbor City, Atlantic county, took up the refrain. Au Rahway, Union county, reports apple trees infested with tl and Rancocas, Burlington county, reports their presenc comment. September 3d, the insects were reported from Monmouth county; Kingwood, Hunterdon county; Trento county, where they also attacked vegetables, and Lakewo county. September 10th, they attracted attention at Sout Essex county; New Brunswick, Middlesex county; Cranfo county; Kingston, Somerset county; Pittstown, Hunterdo Cape May Court House and Cape May City, Cape May cou field township, Cumberland county, and Egg Harbor City county.

The pest was thus recorded throughout the State and served all the notice it received.

Cut-worms were first noted at Mantua, Gloucester county, and the week following they were numerous at Woodbu 28th, they were reported from Middlebush, Somerset co Fishing Creek, Cape May county. June 11th, Pottersvill don county, reported them as injurious enough to make of corn necessary, and Trenton Junction, Mercer count them as numerous.

The first report on the *Colorado Potato Beetle* was May 21s encouraging; Cranbury, Middlesex county, recording it n merous as usual; but this was not so of Woodbury, Camd May 28th, the insect was reported from Paterson, Passai Cassville, Ocean county, and Woodstown, Salem count latter point less numerous than usual. June 11th, the in numerous at Kingwood and Sergeantsville, Hunterdon c South Bound Brook, Somerset county, they were dest newly-set tomato and eggplants, and shared with the s the honor of a report from Fishing Creek, Cape May coun 18th, the beetles were troublesome at Cranford, Union co apparently, nowhere else. June 28th, they were "num Huntsburg, Sussex county, and "destructive" at Linc Morris county; Layton, Sussex county; Frenchtown, I county; South River, Middlesex county; Salem, Salem co Shiloh, Cumberland county—at the latter point tomato cluded in the injury. July 2d, they caused much damage town, Hunterdon county, and, on the 23d, injury was Huntsburg, in the same region.

rawberry Weevil was reported as injurious cnce only, May
n Deerfield township, Cumberland county.

lum Curculio was first referred to May 21st, from Moores-
rlington county, and then as not so bad as usual. June
n the other hand, was reported as injuring much fruit at
n, Gloucester county.

ice held their own well, as injurious forms. The first com-
me from Mickleton, Gloucester county, and was of the
nfesting cabbage. This seems to be the only record of this
hough, on August 20th, Seargentsville reports what is prob-
same species on turnips and radishes.

apple trees were noted June 4th, at Mickleton, Gloucester
n numbers sufficient to endanger the crop. June 18th,
reported from Hazlet, Monmouth county, and covered the
Rahway, Union county. June 25th, they caused the drop-
uit at Middleville, Sussex county, and at Elizabeth, Union
vere troublesome. July 2d, fruit was dropping badly, and
infested by lice at Hanover, Morris county.

trees were unusually infested, the first report coming June
n Newton, Sussex county, where they caused fruit to drop;
were also numerous at Hazlet, Monmouth county. June
llington, Morris county, reports that "cherries do not
being covered with lice," and Middleville, Sussex county,
e fruit dropping from the same cause.

peach trees were reported June 4th, from Cape May Court
Cape May county, and June 25th, from Plainfield, Union

tion of fruit trees, in general, is reported from Plainfield,
unty, June 11th.

a Louse was first noted June 11th, at Cape May City, Cape
nty. June 25th, late peas were infested at Mickleton, Glou-
unty, and July 2d it was again reported "destructive"
same point. July 9th, "many acres of peas ruined by
nes from Fishing Creek, Cape May county.

Lice were reported once only, July 2d, from West Freehold,
h county.

Lice were noted on citrons, July 2d, at Mickleton, Gloucester
July 30th, they were "very numerous" at Beesley's Point,
y county, and August 13th had "practically destroyed"
ls of cantaloupes at Mickleton, Gloucester county. August
phids destroying all vine truck" is the discouraging report

from Mount Holly, Burlington county, and this marks
that season.

The *Fly in wheat* is first noted May 28th, from Medford
county, though incidentally, and the Angoumois grain
referred to June 25th, as appearing in wheat fields at
Mercer county. Injury by the "weevil" is reported Ju
Kingwood, Hunterdon county, and on the 16th, both
"weevil" are noted at Frenchtown, Hunterdon coun
16th, the "fly" was troublesome at Somerville, Some
The Angoumois grain moth was noted September 10th fr
bush, Somerset county; was doing much damage to stack
Sergeantsville, Hunterdon county; considerably effecte
New Egypt, Ocean county, and badly infested wheat a
Cumberland county. September 10th, the moth was
wheat from Rowlands Mills, Hunterdon county, and
Gloucester county, states that "owing to prevalence of
moth less wheat will be sown."

Squash-bugs were numerous at Fishing Creek, Cape
June 11th, but were not again reported.

Currant-worms attracted attention at Frenchtown, Hunter
June 25th, and on the same date the *sweet potato flea* wa
siderable damage at Salem, Salem county, some
destroyed.

Codling-moth was noted July 16th, at Deerfield,
county, and on the same day "small and wormy" app
ported from Ocean View, Cape May county.

Corn or *boll-worms* became troublesome in cornfields
Court House, Cape May county, July 23d, but seem not
come noticeably abundant elsewhere.

Tomato-worms, or "horn-worms," attracted attention
destroying some fields at Fishing Creek, Cape May c
Kingwood, Hunterdon county, they were troublesome A
and were again referred to on the 20th.

Cabbage-worms were numerous or destructive, Augu
Landisville, Atlantic county; Metuchen, Middlesex c
Salem, Salem county.

Large Caterpillars, destroying the leaves of many plant
at South Orange, Essex county, July 23d.

The "*Army-worm*" in millet fields became injurious
Creek, Cape May county, September 3d, winding up
which insects had been unusually varied in kind and
injury.

ANBERRY KATYDIDS AND GRASSHOPPERS.

st plague often becomes serious in South Africa, and de-
rarms appear in some portions of that continent almost
The species there in fault is one of the *Acridiidæ*, or
ed grasshoppers, and is an ally of our "bird locust," *Schis-
ricana.*
ects fly in immense swarms from their breeding places,
covering an area several miles in extent, and on it devour
thing. Similar "locust" plagues are not unknown in
n States, and for a time it seemed as though we were help-
pposed to them. It was noted in Africa that sometimes
were ravaged by an epidemic disease, and that individuals
great numbers. It was also found that sick individuals,
to a mass of healthy ones, infected them with the same
ence it was determined to test the possibility of propagating
ly. Pure cultures were obtained, and it was found feasible
e the disease into previously healthy swarms. Good suc-
en reported from Cape Colony in practical workings with
, but I have no details enabling me to judge the conditions
enable it to reach its maximum effect. The idea of fight-
with diseases is fascinating, and appears again and again
s attempt or an idle suggestion. Some attempts have met
siderable measure of success, but always it has been found
ss depended upon some definite combination of weather
and insect abundance. In the fight against the cinch-bug,
our Western States, it was found that in a drought, when
were most abundant, the disease was least effective.
ther and other conditions are favorable epidemic diseases
flourish whether artificially introduced or not. During the
901 thousands of the caterpillars that were so unusually
were carried off by a disease that left their dead and dry or
es everywhere on trees, trunks and fences. I always look
ttempt to use natural agencies in an unnatural way as un-
say the least, unless we can also furnish the surroundings
their effective action. In other words, epidemic diseases
out of existence great multitudes of insects when circum-
or their development, but they may lie dormant for years
h circumstances arise. In New Jersey a disease each fall
a considerable number of our common Carolina grasshop-
t has never been epidemic, and cannot easily become so,

because the insects are not sufficiently numerous to bri close contact with each other.

Grasshoppers are charged with causing much injury t each year, and katydids actually do cause serious an some bogs.

Mr. Joseph J. White, of New Lisbon, is one of the s katydids, and it occurred to him, after reading of the S experiments and their good results, that possibly the d be equally effective on our bog species of short-horns, katydids. He therefore communicated with South Afri for a supply of cultures, and turned the matter over t daughters, Miss Elizabeth C. White, who kindly gave m ing account of her doings:

"A supply of locust fungus was ordered to be sent i stallments, about a week apart, to insure one or two, at received. The first was mailed March 1st, by Alexand M.B., Director of the 'Bacteriological Institute,' Grah Cape of Good Hope, and was received by Joseph J. Lisbon, N. J., about the first of April. Three other c were sent and received about a week apart, making in a tubes of the fungus.

"About the first week of June a few short-horned were found in bushy corners not reached by the water i flooding of the bogs. These were dipped in a culture ma or two tubes of the fungus, according to the direction week or ten days later three or four more tubes were n such hoppers as could be found were dipped. These nearly all, of the short-horned varieties. In the last d many small, long-horned hoppers were found in a youn short, soft water-grass was plentiful. Hundreds of these and dipped in a freshly-prepared culture of the fungus. was repeated about a week or ten days apart through Ju tubes of fungus being made up at a time. No specia made at this time to catch katydids. The majority of in were the long-horned grasshoppers, but a few—two or t katydids generally came in for a dipping at each cu fungus. I think the first one was caught about the last or the beginning of the second, week in July. Its win rudiments.

"There was no apparent result from any of these di being under the impression that the long-horned me

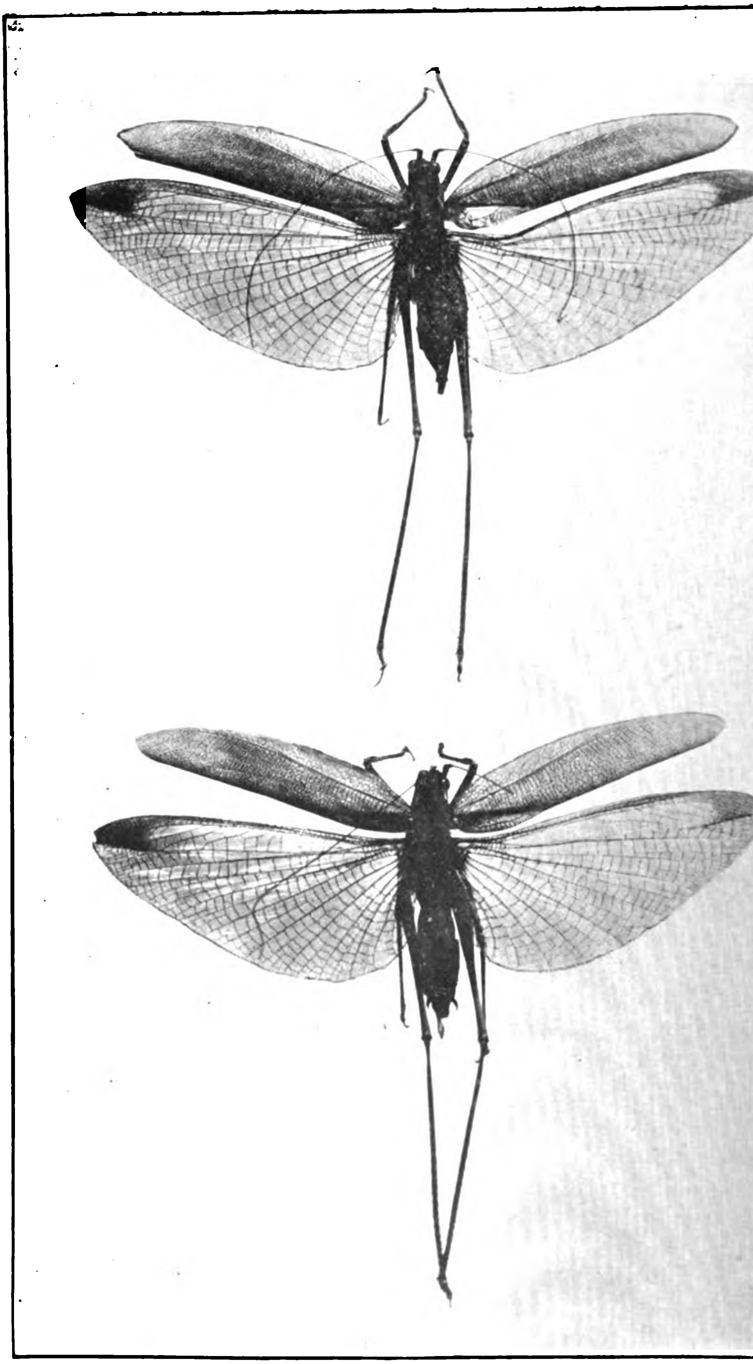


Fig. 6.
The Cranberry Katydid, *Scudderia texensis* Saus , a little enlarged ; male above, female be[low] an original photo.

e the mischief makers, we tried feeding them in cages, the following record:

d—Fungus culture set about noon.

th—The culture seeming well grown; grasshoppers were meadow, where they were apparently feeding on the seeds rass, and about twenty were put in each of these gauze

g—Hoppers with bunch of red-top.

bag—Hoppers dipped in culture, with bunch of red-top.

ag—Hoppers with bunch of red-top dipped in culture.

th—All hoppers in all bags seem comfortable.

th—Two dipped hoppers and one fed hopper dead; the the bags sprinkled.

th and 29th—The grass sprinkled; no apparent change in

ly sprinkling of the grass was continued for several days, rasshoppers continued in good health.

ought us to the end of our private resources, and we sent nswick for help. The experiment of feeding katydids of which the notes follow, was under the direction of hn B. Smith.

21st—Mixed three quarts of fungus culture with about five d boiled water, and thickened the mixture with bran till d not drip. Spread most of the bran at the sides of ll Centennial bog and across the top of the early Black

thirty-one (31) katydids—18 males and 13 females. Sent es to Prof. Smith, and confined the rest in two bags, led as to numbers and sexes. In each bag placed a small bran mixture, and in one (No. 2) a bunch of cranberries In a very few minutes a male began to eat greedily of bag No. 2, and soon a male and female were eating in

22d—Bran eaten in both bags, but most in No. 1. e day a lot of berries eaten.

23d—Three females dead in No. 1 and one male in No. 2, ; bodies eaten by other katies. At noon, two more dead nore berries eaten in No. 2.

25th—One katy dead in No. 2.

26th—Three more katies dead in No. 1.

28th—Two more katies dead in No. 1.

"This finishes the daily notes, but the insects w cages two or three days more, when all in bag No. 1

Mr. White wrote me early in August, and I res ately, asking for a tube of the culture and a copy for use. August 13th, I received four tubes. Th the form of a dark brown, long-drawn drop of to matter, partly adherent to the tube, and at such poi cottony growth or substance. The free surface of string was clean in all cases. The directions were i printed circular, of which the following is a copy :

LOCUST DISEASE FUNGUS.

Small tubes containing this fungus are prepared at this Insti all applicants, who may also obtain them by application throug sioner of their Division.

The methods mentioned below should be followed, and t watched and reported to me.

Highly satisfactory results have hitherto been obtained, an requested that all persons using the fungus will report the re ments to this Institute.

During dry weather it is difficult to get the disease to spread, a able to use it in moist, wet weather, and to make the infections before sunset.

DIRECTIONS FOR PREPARING THE FUNGUS PREVIOUS

Open a tube and take out the contents entire; add it to two t and rub the whole together with a spoon or flat knife, so as t rial and mix it thoroughly. Then dissolve this in three-quart water, which has previously been boiled and allowed to cool. pieces of cork, which have been previously steeped in boiling w

Now cover the tumbler with a piece of paper, and let it stand warm corner of the house, or until the fungus is seen to be pieces of cork.

METHOD OF DISTRIBUTION.

(1) Catch some locusts, and, after dipping them into the fung the swarm again.

(2) Smear patches of damp ground, where the locusts aligh fungus.

(3) Confine some locusts in a box which contains some favou with the fungus, and, after the food has been eaten, return the lo

(4) Collect a large number of locusts which have died from hole in the ground about eighteen inches deep and one foot wide

Strew some locusts over the bottom, then sprinkle some water with locusts and again sprinkle until the hole is full. Do not p the hole, but leave them lightly packed. Then cover over wit

eep the hole thus carefully covered for four or five days. If very warm
· days will be sufficient, but if colder a longer time will be required.
l of this time remove the locusts and spread them out in the sun for an
or until thoroughly dry. Now grind them into meal.
al, which may be kept dry for a long time until wanted, take two table-
d add it to a large tumberful of water, into which some sugar has been
ave this in a warm place for twelve to forty-eight hours, and then treat
by dipping, etc., just as one does in using the fungus when supplied in

METHOD OF APPLICATION FOR VŒTGANGERS.*

t one pound of white bread; dry it, and then grate it down to coarse
t a cupful into a bowl and add enough water to make a watery paste.
he contents of one tube of fungus, and keep it in a warm place until the
en to be growing over it. Now, place small portions where the vœt-
appearing, and take care to see that where not eaten up the small
kept moist from day to day until they have been eaten.

ALEXANDER EDINGTON, M. B.,
Director Bacteriological Institute,
19th, 1899. *Graham's Town.*

t lot was prepared August 14th, directions being closely
The culture was cut and carefully broken up with the
small fragments. Water was freshly boiled, cooled to
kewarm, and then added to the sugar and culture. Bits
re also boiled and floated in the mixture while yet a little
was then poured into a beaker, covered with cardboard,
disturbed until August 18th, when it was poured into a
carried to New Lisbon, to be employed on the bogs on the
is was No. 1.
er tubes were prepared August 15th, and the culture, hav-
ut into very small pieces, was ground with the sugar in a
tar and thoroughly broken up. Used for one lot, boiled
oughly cooled and placed in a covered tumbler. This was
he next lot was prepared as before, but put into a wide-
ottle, which was corked and marked No. 3.
t lot was prepared with unboiled, distilled water from the
Laboratory—but the bits of cork were boiled before being
he mixture. This was No. 4.
16th—Culture No. 1 showed signs of a fermentative growth,
tire mass was turbid, with a streaky admixture. Of the
ture No. 2 showed only little signs of growth; culture No.
evident signs of growth in the mass, and culture No. 4
almost clear.

s—Foot-goers: the local term applied to the larvæ or wingless forms.

August 18th—The corks in all the cultures began to sh at the edges, and the liquid was somewhat opaque and s the late afternoon all were put into four-ounce bottles, tig and packed for transportation. The conditions had be for growth, the temperature being close to 80° at all times phere humid.

August 19th—Reached the bog at about 10:30 A.M., a assistance of Miss White, captured a large number of which were thoroughly dipped and released. Altoget about twenty-five katydids, half a dozen *Conocephalus*, ov dred meadow grasshoppers, *Orchelimum* and *Xiphidium*, a hundred *Acridiids* or short-horned grasshoppers, *Melanop* and *Acridium*. The conditions for the disease were fav was very hot and sultry. The bogs also were very sprinkled what remained of bottle No. 2, after dipping, tractive patch of berries.

Only one bottle of the culture was used in this wa realized that the katydids, which were the main objecti scattered that the idea of starting an epidemic, based on individuals, was a hopeless one. The truth is, the *number* o not so large; but their voracity is so great and their li long that the injury caused is altogether out of proport abundance. A single individual will often eat the seeds f six berries at a single meal. As they live on the bogs ov 150 berries for a single insect is not an extravagan *Conocephalus* and *Orchelimum* probably assist materially i of destruction, but they are also somewhat rare, and only of all the long-horned grasshoppers, is really plentiful. cranberries no fruit could remain on the bog, because so a grassy area, the insects are as abundant as the berries t

After looking over the subject carefully, it was deemed to spread the infection, if possible, through the food, an mixture was recommended. Miss White has reported she did.

It remains to add that she sent me some of the dead ferred to, and that in no case was there reasonable cause, scopic study, for believing that the death was due to t disease.

Of the bran spread on the bogs, some was apparently no results were noted in a decreased number of *Orthop* kind. The experiment was a failure, and not unreasonab

eads naturally in the great swarms of short-horned grass- iere one individual is in frequent contact or touch with its It has no chance against scattered specimens, and may e fatal to the *Locustidæ*—long-horned grasshoppers and under the best of conditions.

l be said in this connection that, in a recent publication ntomological Division of the United States Department of , it is stated that in Colorado some of the migratory 'e been successfully inoculated with this disease, and from Professor Morgan reports a measure of success. In each es short-horned grasshoppers are the subjects, and in each great swarms, in which specimens were in, or came into, t with each other.

FIELD RECORD.

me of my first visit to the cranberry bogs, August 19th, ls were obviously immature sexually; that is, they were ıdy to reproduce. This was determined by examining the ie female, in which all the eggs were yet very small. The ch form masses on each side of the abdomen, as elsewhere could be readily seen when the body was laid open with a p-pointed scissors. The immense bog area covered by the the wide range of plants which might serve for oviposi- any effort to find the eggs under natural conditions a ertaking, without some clue as to the character of the favored. This was the more so as there was every reason hat the eggs would be laid in leaf tissue, following the allied species as recorded by Miss Murtfeldt, Dr. Riley immock.

l, therefore, to cover certain portions of the bog where ere abundant, with large cages; confine in each a number is and select locations, so as to obtain as large a range of ossible. Six cages were ordered, 3 x 3 x 3 feet, made so adily taken apart and set up. The sides and top were h painted wire mosquito netting, to admit light and air le hindrance as possible. The appearance of one of the wn at Plate Figure 18.

le, Miss White was good enough to send me specimens at als, that I might watch the development of the ovaries. of August some specimens began to show single mature rown color, and the cages were shipped to New Lisbon.

September 6th, I followed and placed them as follows : bushy hummock at one corner of a bearing bog. The covered with vines, but several low plants of the Dwarf leather-leaf or "gander bush" (*Chamædaphne calyculata* cluded. Nos. 2 and 3 were placed close together on a where katydids were abundant and berries badly eaten. contained, besides vines, several plants of the common " or sedge (*Carix sp.*), the other, several plants of *Panicum* or "deer grass." No. 4 was placed at the end of the covering very few vines and a mixture of grasses, with a of *Hypericum*. No. 5 was in a corner of a yet younger bo very few vines and a mixture of *Panicum* and *Hypericum*, No. 4. No. 6 was placed on a dam, covered no vines a lot of double-seeded millet (*Panicum viscidum*), a Kalmia three other heath-plants. None of the cages covered cranb only, and in only two of them were there any berries on vines. Into each of these cages at least four females a four males were introduced. The day was intensely ho quitoes (*Culex sollicitans*) were vicious and there was no i to waste time in the field. Next morning I visited all added other specimens and collected largely, to determin of development. Found that it was not yet at the oviposi though many examples had two or more fully-developed Examined a large number of leaves of all kinds growing dams, but found no signs of eggs in any of them.

September 14, again visited the bogs, collecting and a large number of katydids. Found the ovaries mu developed, with often half a dozen or more mature o side, but also many that were yet undeveloped. There ing to indicate that any eggs had been laid, and the a most of the females was much distended. The specim cages were watched for a time and a few others were cage No. 4 a specimen of *Argiope*, the large yellow and bl not uncommon on the bogs, had taken possession, its w the cage lengthwise, and here all the specimens were gon out the spider and restocked the cage, having first exa fully all the vegetation under it, for eggs. The habits of had changed a little by this time. They were not so spread over the bog, and were not eating berries so many tempting patches of ripe berries not a specimen found ; but among grasses and along the dams on the

Fig. 7.

...tomum, or "deer grass," showing Katydid eggs at E somewhat less than natural size. From an original photo.

Fig. 8.

Tip of a spray of *Panicum dichotomum*, or "deer grass," showing the eggs at
eggs have been eaten out, at A. From an original photo—twice natu

s seen. In fact, the tendency to gather along the dams
ıarked and almost every seed on the grasses there was
sorts of exposed seeds were now devoured and favored;
cause they were easier to get at than those of the cran-
amined a large number of leaves of Kalmia, and other
s growing on and along the dams, but found no eggs.
r 23d was the date of my next visit, and cage No. 5
amined. The females had evidently begun to oviposit,
ovaries were much lessened in size and the number of eggs
l as compared with previous examinations. So the plants
ge were systematically scrutinized, leaf for leaf; first the
then a small heath, and finally *Panicum*, or deer grass,
last resort. Here I found the eggs inserted singly, from
tween the upper and lower surface. Plate Figures 7 and
their appearance clearly. Having once identified them,
o further trouble, and I found eggs in every plant under
I also found them, more sparingly, in the same grass on
t was thus determined that the "deer grass" (*Panicum*
was one of the natural places for oviposition, and not
ipon the insect, because nothing else was available. The
aced in a new position, and a number of females, which
appearance had not completed their egg-laying, were
Cage 6 was then examined. A heavy rain had washed
nd banked around it at the bottom and the specimens
eared. Examined first the grasses, and found eggs at
leaves of the "millet" (*Panicum viscidum*). Afterward
arefully all the leaves of the other plants in the cage and
gs in any of them. This cage was not restocked. Exam-
large number of the millet plants on the dams and found
ry fair proportion of them. It was obvious that, while
was in progress, it was a long way from complete. Left
hey were in the other cages, satisfied with the informa-
tained, and returned again to the bogs October 7th for a

te the katydids had become much reduced in numbers,
sluggish and more easily caught than on any previous
Quite a number of the females were found with the
llapsed and ovaries practically emptied. Others, how-
l half a dozen or more fully-matured eggs and a greater
developed. In other words, egg-laying was yet in pro-
g a period of at least three weeks during which this pro-

cess continues. In fact, judging from my previous
and from the condition of affairs at the last visit, I c
from September 15th to October 15th would probably b
cover the entire period. Cage 1, when examined, sho
every plant of "gander bush" or Dwarf Cassandra,
any cranberry leaf. The eggs were placed from the ed
and from one to four in one leaf. They were never
together, and most often there were only two eggs, one
of the midrib. In one case a leaf hardly larger than
cranberry leaf contained an egg. There were many lit
this kind on the ridge on which the cage was placed, and
quite a number without finding any eggs, nor did I
similar plants later in the day, though I examined a la
After the eggs had been once found it was easy to det
presence by holding the plant toward the sun. The
opaque spot that was recognizable at a glace ; hence all
a plant could be examined in a few moments. My
that, while the insects will use the heath-plants for egg
poses when driven to it, they will not do so as a matt
when their normal host-plant is present. Cage 2 con
sedge or bog-grass other than cranberry vines, and I fou
every leaf of the sedge one or two eggs, separately p
immediate vicinity of this cage had much of this sedge g
I cut and examined many plants, finding no eggs outsi
I conclude, therefore, that this also is not a normal hos
that only necessity will induce the katydids to oviposit in
can do so. Cage 3 had *Panicum* as well as sedge, an
found on *Panicum* only. Cage 4 also had *Panicum* as well
(St. Johnswort), and eggs were confined to the former.
were now found on the bogs and dams, but few on the b
pared with the dams. The insects leave the lower, dam
select by preference, for egg-laying, the higher, dry are
"deer grass" the upper leaves are selected, and I rarely
than one egg to a leaf outside of the cages. On the mil
leaves were favored, and on one I found as many as six eg
laid by one female at one sitting. Two, three and even fo
not uncommon, and my conclusion is that this grass (*Pa*
dum) is the preferred host-plant of the cranberry-eating k
grows on all the dams, and especially along the cart-ruts
it is on recently-stirred land only. Mr. White informs
grass tends to run out after a few years, as the ground fi
and they do not consider it a menace on their young bog

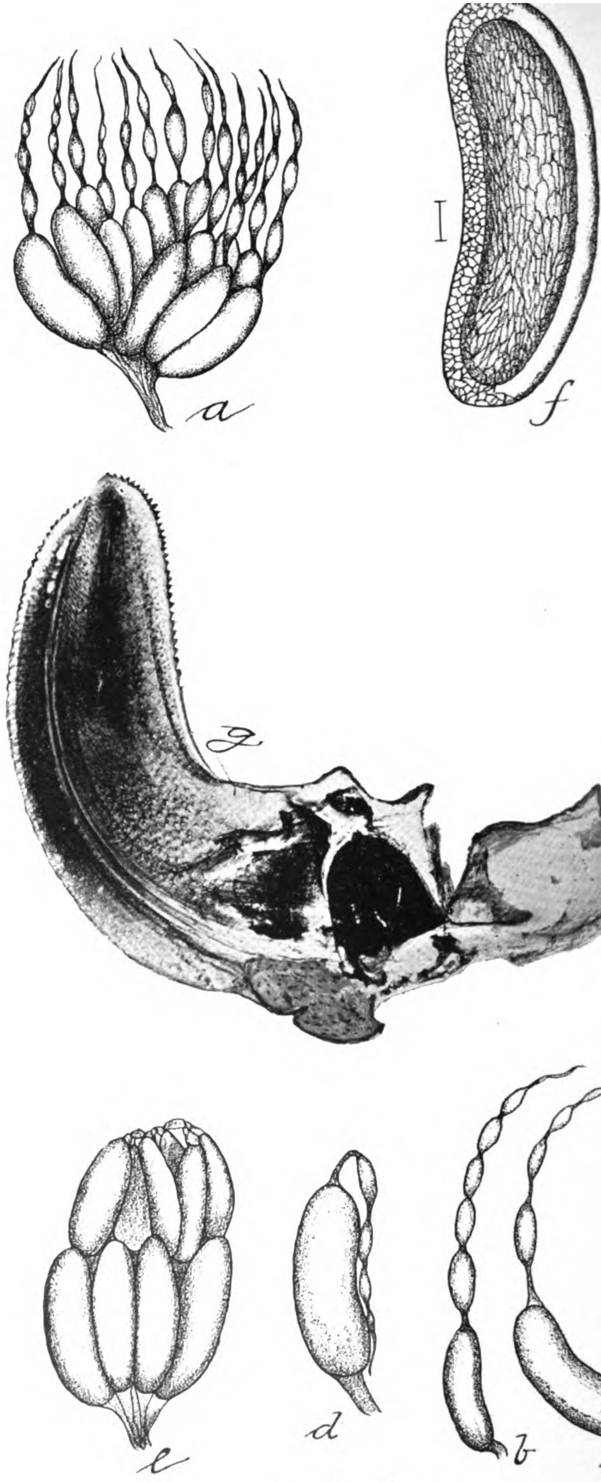


Fig. 9.

Ovary, egg and ovip sitor of Cranberry Katydid. *a*, ovaries in Septembe
tube of same date ; *c*, single ovarian tube further developed ; *d*, shows the infold
tion of ovarian tube ; *e*, ovaries in early October, showing eggs almost mature i
single egg ; *g*, the ovipositor from the side. All are enlarged and all original—*g* f

ond choice, there is *Panicum dichotomum*, or deer grass, and more commonly on the bogs and sides of dams. On the so runs out in time, but maintains itself along the edges ne dams. It is, perhaps, the more common host for the nfesting older bogs. It is probable that any other species n would be acceptable to the insects, and, as I have shown, when driven, take almost anything other than cranberry. whether they would take cranberry if anything else was but I would not like to say they could not do so.

r the eggs laid on bogs covered with water during the win-rvive, is a question. It seems probable that they cannot, ure katydids are rarely seen there. The eggs of the *Xiphi-* smaller long-horned species—certainly do survive, but much better protected than those of the katydid.

Life History.

stated, the life-cycle of *Scudderia texensis*—the cranberry s as follows: Eggs hatch about the middle of June; the w slowly, and reach the pupal stage about July 15th. lults appear early in August, and remain until well along . Oviposition begins about the middle of September, and owly for almost or quite a month. Few eggs mature at n the ovaries of the female, and she lays from one to six g—the latter an extreme rarely reached. The preferred are species of *Panicum*, but others may be used in case y.

Eggs and How Laid.

eferred in my general account to the ovaries and to the nt of the eggs in them. Early in the life of the adult e organs are rather small masses or bundles lying far back omen, one on each side, partly under the digestive system. , when hardened in alcohol and teased out a little with solve themselves into a number of tubes, converging at the l top, and each with a number of enlargements or swellings. varian tubes, and in them are the developing ova. The ber from 13 to 15 on each side, and in each are five swell-ning eggs. Potentially, therefore, an individual katydid ce 75 eggs in each ovary or 150 all told; as a matter of fact oes this. Copulation has been observed to occur during the

early days of August and probably occurs throughout even later. Males in good condition were found as late of September. After the female is impregnated the slowly, and only the lowest egg in each tube increases i the first days of September we get the appearance shown Here all the eggs of the lower series are developing a remain, very little, or not at all enlarged. Not all the equally enlarged and one or two become brown on each sized before the others begin to change color or have at dimensions. The ovaries are now of considerable size part of the abdominal cavity. The tubes above the lowe over so that they lie in the spaces formed between the A single ovarian tube is shown at Figure 9*b*, represen of development shown in the preceding figure. As the creases in size, the space between it and the next ovum shown in Figure 9*c*, and then the single tube is bent c in Figure 9*d*. If, therefore, we examine an ovary abo of September, we will see a mass of large eggs, and, tween them, the tubes containing those that are undev of the eggs are now fully mature, and the others are so ing full size that it is no longer possible for them to li series. The smaller and less developed examples s lower part of the ovarian tube lengthens, and we get t of a double series, as shown in Figure 9*e*. By this ti begins, and toward the end of September the numbe lessens materially, while in October the females have collapsed, and with few or no developed eggs. Exa time, the ovarian tubes are shrunken and show no in any of the ova yet rudimentary in the ovarian tubes h of development. The specimens are now listless, fly at all, and have a generally collapsed feeling that ind of their existence. They have also become much red ber, and evidently their season is nearly over. In though each ovarian tube indicates five egg cells, yet, fact, only one develops, so, instead of the possible 1 female individual actually lays only 30, or less. Ho she requires to complete her task I do not know, but th laid at one time is clearly proved by the fact that amo mens captured and examined on the bogs September them had several ova on each side in varying stages of while it was obvious that some eggs had been already

number remaining was less than would have been the case
e.

e growers to whom I have shown the eggs in position in the
ive expressed surprise at the possibility of the insects accom-
so delicate an operation as cutting a pocket in so thin a leaf
ing an egg between the upper and under surfaces without
g either. The operation has not been observed in this spe-
t so long ago as 1874 Dr. C. V. Riley published in his Sixth
Report the following account of observations made by Miss
urtfeldt : "The female stations herself firmly, by the mid-
hind legs, on twigs or leaves contiguous to the one selected
e the egg. This leaf is then grasped by the front feet and
vertical position, while the edge is slightly gnawed or pared
e jaws, to facilitate the entrance of the point of the ovipositor.
is is done the abdomen is curved under and brought for-
d the ovipositor is seized on its convex edge by the man-
d maxillæ, which, with the aid of the palpi, guide the point
ortion of the leaf prepared to receive it. After gentle but
efforts, the point of the instrument is finally inserted be-
e tissues of the leaf and gradually pushed in to more than
ength. As soon as the cavity is formed, the egg is extruded
ed slowly between the semi-transparent blades of the ovi-
As the egg leaves the ovipositor the latter is gradually
n, while the egg remains in the leaf, retained in its place,
, by a viscid fluid that is exuded with it. The insect
lly deposits two or three eggs in succession, but, as a rule,
is placed she releases the leaf and betakes herself to eating,
ng her feet, or dressing her antennæ, and does not resume
rnal duties for some time."

ore than probable that this is very nearly what occurs with
berry species, and that only a few eggs are placed at one
Dr. Riley mentions five for his species, but Mrs. Dimmock
a birch-leaf about three inches in length, in which she
102 eggs around its edge. It would be interesting to know
y specimens co-operated in this performance.

ipositor with which this work is done is a curved scimetar-
n about one-quarter of an inch in length, and by no means
structure, since it is made up of six distinct pieces.
gure shows a side view made from a photograph. Two of
s of one side are very clearly shown, and the fact that the
furnished with fine saw-teeth is apparent. The other, or

third piece of this same side, lies inside of the two sh picture at about the line of the division shown. This in narrower than the others, of even width throughout, with a pointed tip. It has no teeth, is not used in the mechan cutting the leaf, and serves chiefly, if not entirely, as a egg as it passes between the two sides of the ovipositor. feldt suggested that the egg is held in position in the lea substance when the ovipositor is withdrawn, and this correct. I have tried to separate out the egg from it several specimens, and have always failed to do so wi breaking the shell or leaving parts of the leaf tissue ad If the edges of the pocket are closely trimmed around th pair of scissors, so as to separate completely the upper surface of the leaf, the two parts nevertheless adhere so c surface of the egg that they cannot be parted.

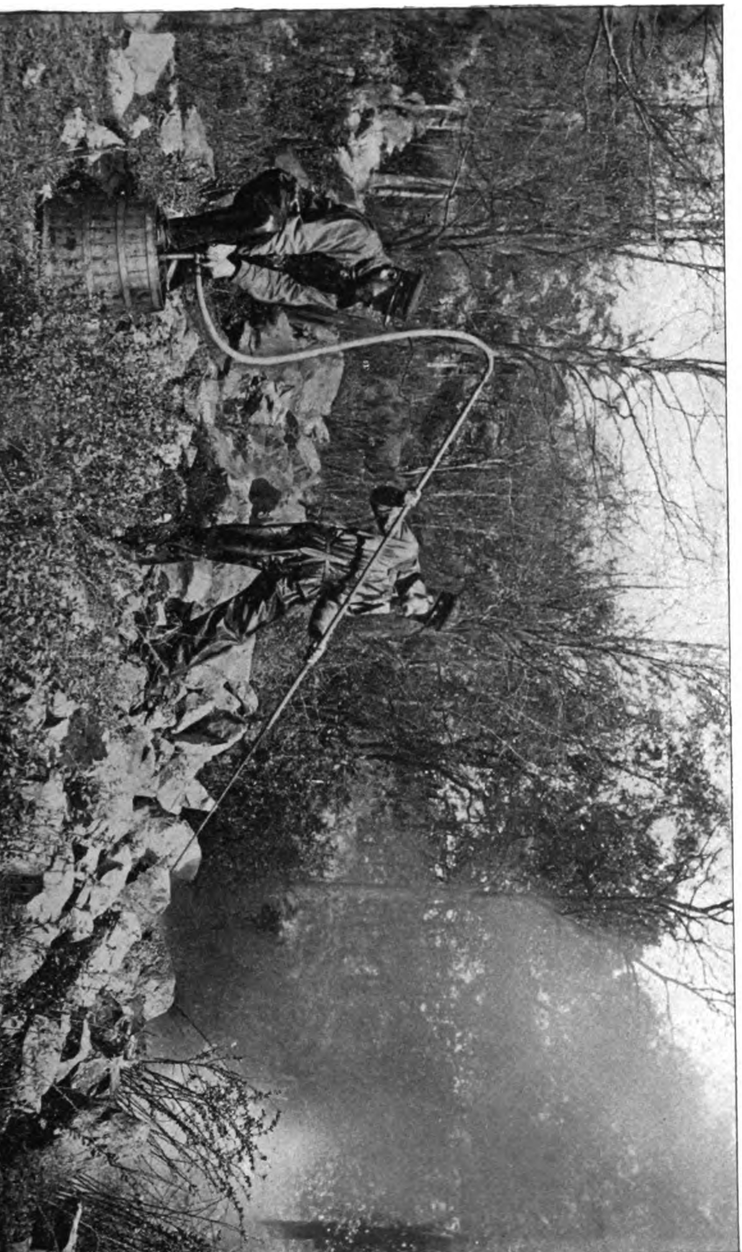
When deposited in the leaf-tissue the egg is almost thre of an inch in length, less than half as wide, very flat kidney-shaped—that is, the ends are rounded, the o somewhat convex and the inner correspondingly concav it is light leather-brown or somewhat dirty clay-yellow. microscope their is a narrow, smoother edging, the surfac regularly marked with hexagonal reticulations at the the concave, inner side. The central surface is closely marked or netted without definite pattern.

Remedial Measures.

The observations made have been given in some detail to an intelligent consideration of this subject. We ca reliance on disease; the food-habits are such as to prec of insecticides; turkeys, though quite effective on a limit considered objectionable and unsatisfactory, for a variety by the owners of extensive areas.

Several growers have told me that after burning over surrounding the bogs they have noticed a marked dec number of katydids the season following. In fact, I h this practice because of my conviction, based upon the k the habits of allied species, that the eggs were deposited near the bogs in leaf-tissue.

Having determined the actual host-plants, the obvious to burn over during the winter all grassy areas surroundi



.ms. This can be done at any time after winter has set-
est done when the ground is frozen, that the fire may not
turf. Do not take any action until the egg-laying season
ver and the water is on the bogs.
are very grassy should, if the grass is a species of *Pani-*
ıred as well as possible, or, if that be not feasible, the
be mowed after the middle of October. The grass is
nd the eggs are laid in the upper leaves of the *P. dichoto-*
r grass. Hence, it can be cut above the vines with a
on new bogs, a mowing machine may be used if the
provided with lawn shoes. There is no necessity for
r burning it. It will decay in the water long before the
wing.
ng over dams or underbrush without starting a large fire,
ike that used by the Gypsy Moth Committee, in Massa-
d termed by them a "cyclone burner," would be very

ssentialy, a twelve-foot gas-pipe, at the end of which a
Vermorel nozzle with a very fine opening is fitted. Half
is encased in wood, that it may be safely handled, and
connected by a short hose with a small pump fitted in a
ket. Figure
is from the
h report for
explain more
pump is op-
e man, while
ects the noz-
il emerges as
t-like spray,
asily lighted
with a very
t, destroying
in its path in
without ne-
ting much, if
Every leaf

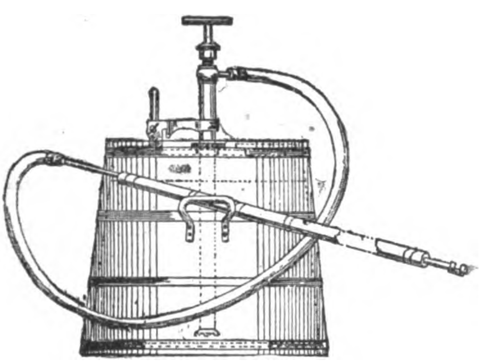


Fig. 11.
The cyclone burner: shows the general construction.
(From Forbush and Fernald, Mass. Bd. Agl., 1896)

rnt off any shrub without more than singeing the wood,
ss could be burnt off the surface without even thawing it.
s oil was used in Massachusetts, but simple crude petro-
o if the odor is not objectionable. A special oil hose is

advisable if much work is to be done, because the oil
nary rubber. So no solder can be used in the nozzle fitt
of the intense heat of the flame. It seems scarcely n
into more detail on this point, as, with the problem c
our cranberry growers are perfectly competent to work c
of the application.

The Species.

Since my previous writings on the cranberry Or
Samuel H. Scudder, of Cambridge, has published a re
species belonging to this group, and the name applicable
is found to be *Scudderia texensis* Sauss. It is the same
called *Scudderia furculata* in my Bulletin No. 90, the
being no longer used for any of our forms. All the spe
on the White bogs this year were of this species. I
examples of the larger form, called *Microcentrum*, but
rare that they could hardly be counted as worthy of atte
my collections of previous years it is probable that on
(*Scudderia furcata* Brun.) also feeds on cranberries, and th
that probably lays its eggs in the leaves of oak, birch an
It is likely that, where such trees come close to the edge
insects will get on it and eat berries. Hence it is advis
out the undergrowth for some distance back from the ed
them of their natural retreats and remove temptation fr
may appear further off.

MOSQUITOES.

New Jersey has always had a reputation for having
ous and fiercer mosquitoes than any other of the United
newspaper writer and the caricaturist have both found
say concerning this one of our products; so that the
quito is scarcely less celebrated than the Jersey lightnin
had these insects pictured as carrying off cattle; as lyi
the new arrival at the summer boarding-house; as s
their bills on the grindstone, preparing for the seaso
Of course, there is some basis for this ill-report—not t
sey is really worse than some other localities in the U
Staten Island and Long Island will rival the New Jerse
number and bloodthirstiness of its product; and who
been in the North woods does not remember the swarm

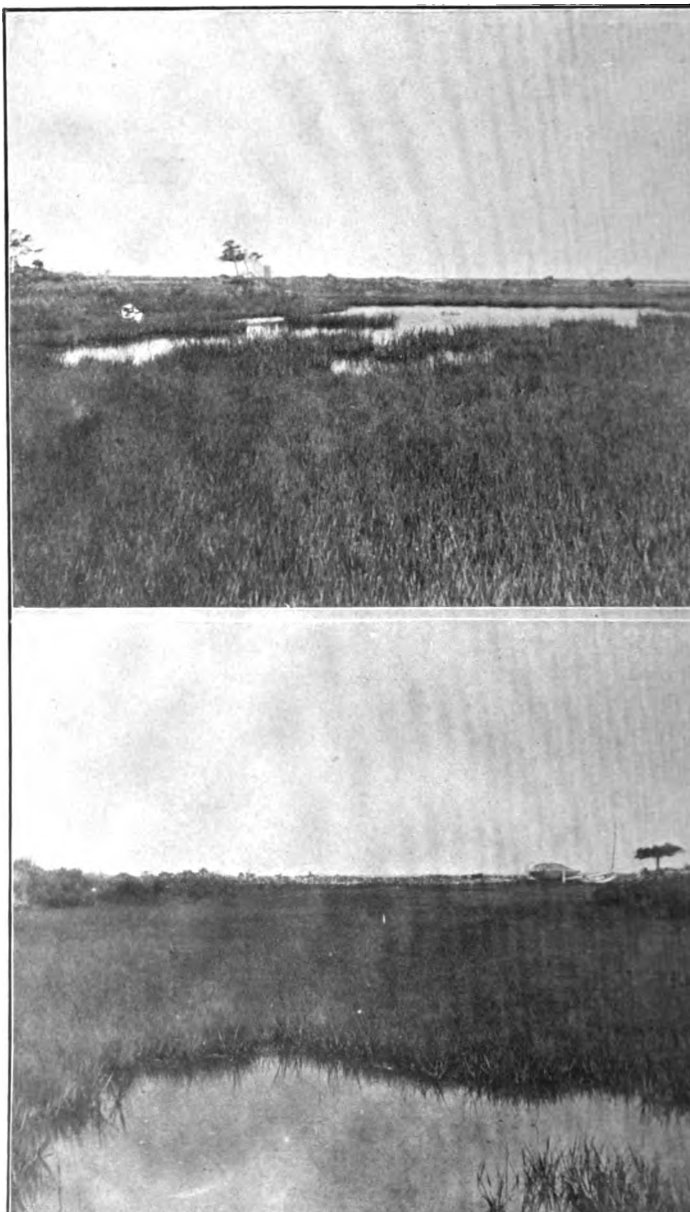


Fig. 12.

Typical areas where *Culex sollicitans* breeds. Small pools are in the meadow everyw
the whole is a great sponge in which the boot sinks from 4 to 6 inches. From origina

the tar mixtures that were required to preserve even a of comfort, while hunting, fishing or sitting outdoors at t is not a matter of climate, because they are worse in ouisiana than they are in parts of New Jersey; and very se in Alaska, at the very fringe of the Arctic regions. It a matter of opportunity for breeding, and in that respect y offers peculiar advantages. Not all parts of our State y infested; there are some sections where the mosquito is l; where the season may be passed without a single speci- g noticed, and where, from the practical standpoint, they attention whatever. But we have a long coast line, from Jersey City to Cape May; indeed, practically, xtends along the valleys of the Hackensack and Passaic a considerable distance north, around Cape May, along s of the Delaware bay, and for a considerable distance elaware river. Along the Atlantic coast the tendency formation of a series of bars. This begins at Sandy eaks at the Highlands and, beginning again at Bay ntinues to Cape May Point. These bars vary in width, also in their distance from the mainland. Sometimes nly a few hundred feet wide; at other times, a mile or casionally the region between this outer sand-bar and the e mainland is almost filled with marshy meadows, usually let or creek running through them, to a neck of land that he bar with the mainland. At Barnegat bay the distance ntil it is four or even five miles in width, and at Great bay considerable body of water. On the bay side of these sand- on the shore of the mainland, we have immense stretches shes, and these run a considerable distance up the streams into the bays. The whole vast area so generally described immense breeding place for certain species of mosquitoes. to the seashore, in crossing these marshes, finds that the mes filled with mosquitoes, even before he reaches his n, and, if he arrives when a land breeze is blowing, life is bearable. There is a decided difference in the number of s at different points along the coast. In some places mos- e present only under certain conditions; at others they are undant—always a nuisance! Were it not for the presence nsects there would be no more delightful summer resort hole stretch of New Jersey coast, from Bay Head to Cape offers everything that is attractive to the fisherman or any-

one enjoying aquatic sports, while to him that seeks h breezes furnish an inexhaustible supply of the best k Yet many people will not go to this shore solely becaus quito pest. Those who would otherwise do so will r tages or more pretentious homes because of the difficult out the insects and because of the necessity of barrin with netting, if even a fair amount of comfort is to when the wind comes from certain directions. I have t this whole coast, not only during the past summer, bu years, and I feel that I am safe in saying that the va property would be many times multiplied were it r insects, and that the number of people going to the sh many times increased did not the dread of the mosqu off the would-be visitors. It has been no unusual e boarders to abandon a seacoast hotel in a body simp the mosquitoes, and many a party has cut short its account. Many millions of dollars are lost in the property and many thousands are annually lost in earni

The importance of the problem has been only recentl public attention. The insect has been with us for so that, somehow, it has come to be the feeling that there to do but to bear with it. Mitigate the nuisance whereve sible, of course, but as to doing away with it in even la seems to have been considered as not worthy of conside it has been shown that the mosquito is not only a nui positive source of danger to health, and in the transf febrile diseases it is a necessary intermediary. Publ directed to the insect for this cause, was ready to heed t that possibly much could be done to lessen the nun pest. Dr. L. O. Howard, Entomologist to the United S ment of Agriculture, has observed the mosquitoes for years past, and during the early part of 1900 publishe which he gave a comprehensive review of what had bee might possibly be done, and included suggestions for gen

It was not possible for me to be long in New Jersey w to some extent, attracted by mosquitoes. I have, the observations, in a more or less fragmentary way, for som and had made a considerable collection of specimens wi ing my studies toward the practical point of dealing wit After the publication of Dr. Howard's book, and in v rather interesting observations that had been made on

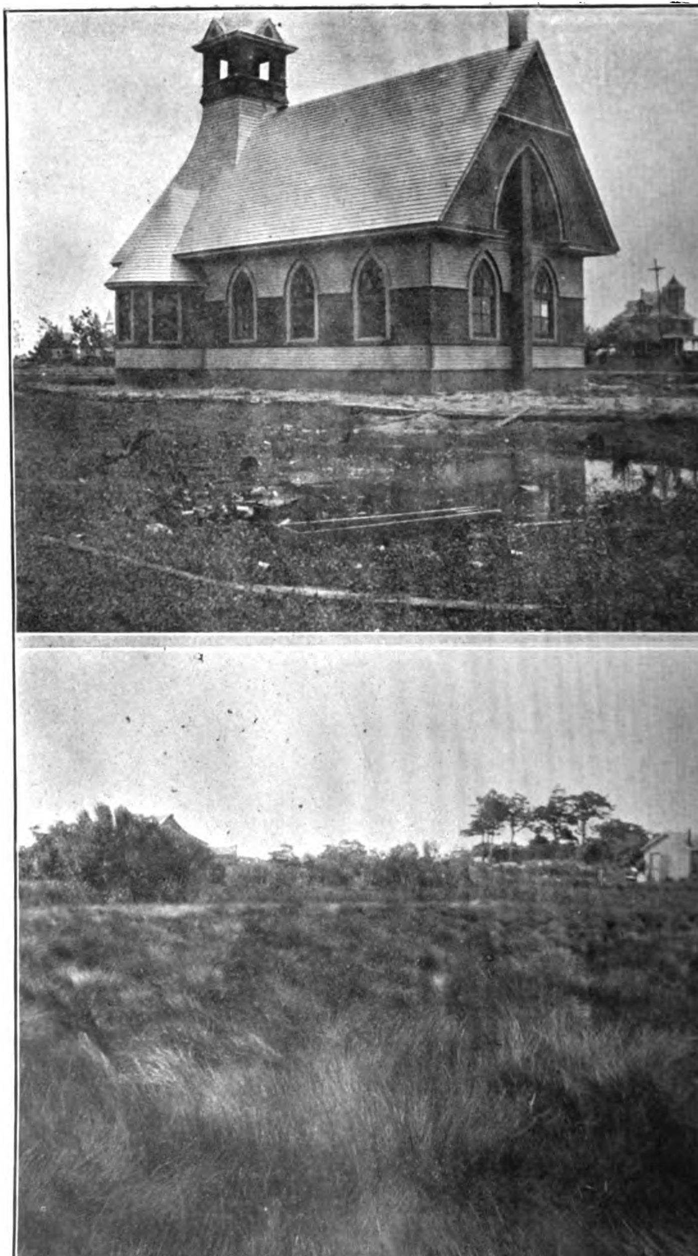


Fig. 13.

Mosquito-breeding places. Above, a church with stagnant pond area next do
bountiful supply of mosquitoes throughout the season; below, a salt meadow with abo
of water, swarming with larvæ of *sollicitans*. From original photos.

rsey species, it was decided to take up the problem in a c way, with the view of determining the possibility of in- the number of specimens and recommending practical for their control. Systematic collections and observations ı made at many points in the State, and in this I have been y aided by a number of voluntary assistants, whose services sewhere acknowledged.

osquito, as a carrier of malarial troubles, is decidedly a State sanitation, hence I determined to enlist the co-opera- ıe local authorities thoughout the State, and, during the : of July, prepared a circular letter, which was sent to the or inspector of every board of health, for which an organiza- reported in the twenty-fourth annual report of the State There are reported 36 cities, 83 boroughs, 136 towns, 3 nd 200 townships—in all, 458 organized boards. To all l to a few other officers, where apparently there were no bodies, a copy of the following circular was sent :

NEW JERSEY AGRICULTURAL COLLEGE
EXPERIMENT STATION,
NEW BRUNSWICK, N. J., July 15th, 1901.

OGICAL DEPARTMENT—EDWARD B. VOORHEES, DIRECTOR; PROF. AITH, ENTOMOLOGIST.

R—It is my intention to devote some time during the present season to tion of the mosquito question as it exists at the present time in New e recently-established connection between malaria and mosquitoes makes important from the sanitary standpoint and gives it a direct bearing alth of the community. For this reason I have asked the co-operation Board of Health and have received from its Secretary, Dr. Henry rdial assurances of support.

sary, however, to make my work complete, that I should also enlist the of local boards throughout the State; therefore, I beg you for informa- following points:

"malaria" a prevalent disease within your jurisdiction—*i. e.*, are the numerous?

' cases are numerous, are they localized or are they scattered throughout ity?

one case apt to be followed by others close by?

re mosquitoes numerous in your jurisdiction, and if so, are they gener- or is one part of the district more infested than others?

ve you observed any relation between the abundance of mosquitoes and ice of malaria?

nosquitoes are plentiful can you tell where they breed?

Vill you send me from time to time specimens of the troublesome mos- our jurisdiction? I will supply as many vials as are needed and will be

glad to give whatever information is desired as to the methods of collec serving.

Eighth. Any further information bearing on the above matters is de be appreciated.

It may be added that the information obtained will not be publisl way so as to prejudice any particular locality, but is necessary to estab relations. It is also to be used as a basis for recommending measures locally abolish the mosquito pest.

Awaiting your early and—I hope—full reply, I am,

Very truly yours,

JOHN B. S

Entomologist to the Experiment Station and State

The replies were not as numerous as I could have they were fairly well distributed, and the information ol interesting. A summary, so far as present applicable, is following page. It soon became evident that the quest trol was at once a simple and a complicated problem; it because the methods of dealing with the pest appear to obvious; it was complicated, because it also became evid occurrence of insects in swarms, at one particular point, dence whatever that they bred anywhere within several place where they were so abundant. Some localities dependent upon a local supply, and, curiously enough, s were found to be very local in their distribution. It w therefore, that while it was quite possible to control th considerable extent, even to a point of lessening them by per cent., this cannot be done if it is left to individu authorities alone. It is quite possible for the village, to ship, in some parts of the State, to practically wipe out systematic work, in its own locality. But there are where local work would be thrown away, because the m ply comes from a distance, and where the local output h a factor important enough to attract attention. There decided that before any valuable recommendation could would be necessary to study carefully the distribution of species, to ascertain the breeding places of those that widespread, and to determine the condition under which if any such there were, would take place. It was necess mine just how far local work would be useful, and how fa necessary for the State to assist, where the control of the strictly a local problem. This investigation has been ma it was possible to do it, during the past summer, but

npleted. In fact, only enough has been accomplished to vhat should be done in the future. It will be readily hat, without any special fund for securing assistance and ny reduction of the regular work of the Station, it was an lity to cover the subject as fully as it deserves. After some tion, I devoted myself chiefly to the study of the habits, places and migrations of the shore mosquito, and the distri- d breeding habits of the malaria carriers. If we consider or salt marsh form in a limited area, it will seem at first as t difficulties were in the way of its control. Some seaside ties have actually done considerable work, with good effect ng the number of the pests; but when one stands at the marsh like that bordering the Great bay, finds the insects uds on all sides of him, and sees the millions of opportuni- ding for miles around, the dominant feeling is one of dis- ent. I have traveled this year from Cape May north to City, along the coast of Barnegat bay, across the inlet to the at Bay Head. I have found at all these points mosquitoes es and in great numbers. I have had my assistant, Mr. , investigating the marshes in the vicinity of Elizabeth Port eadows east of Newark. He has learned some of the con- der which the insects breed there, and the general results e have observed are given in this report. It will need a ained men to go over this whole territory systematically, ete the observation begun this year. It will need a dy than has already been made of the peculiarities of the species, in selecting places in which to breed. It is by no e that all mosquitoes will breed whenever they find a water, though without water there can be no breeding. hem are rather particular as to the localities in which they eir eggs; others seem to find no place so foul or so unlikely will not take an opportunity to oviposit. When we know of all these species, just how far they will spread, and the nces which further their development, we will be in a position ective measure for their control. I can see no reason why, ifficient force, this work could not be done within the ne full year, and why it should not be possible to present, ing of 1903, a general plan for the control of the mosquito h could be begun at any time, in any locality, and system- rried out, until it is reduced to so small a factor as to make s and inoffensive.

To make this investigation as thoroughly as it shoul
require the expenditure of $10,000, that it may be p
pleted and the report available for use in 1903.

MOSQUITOES AND MALARIA.

That there is a direct relation between mosquitoes a
called malaria is generally accepted by investigators
time, but whether or not other factors are necessary fo
occurrence of the disease is by no means as well sett
agreement so general.

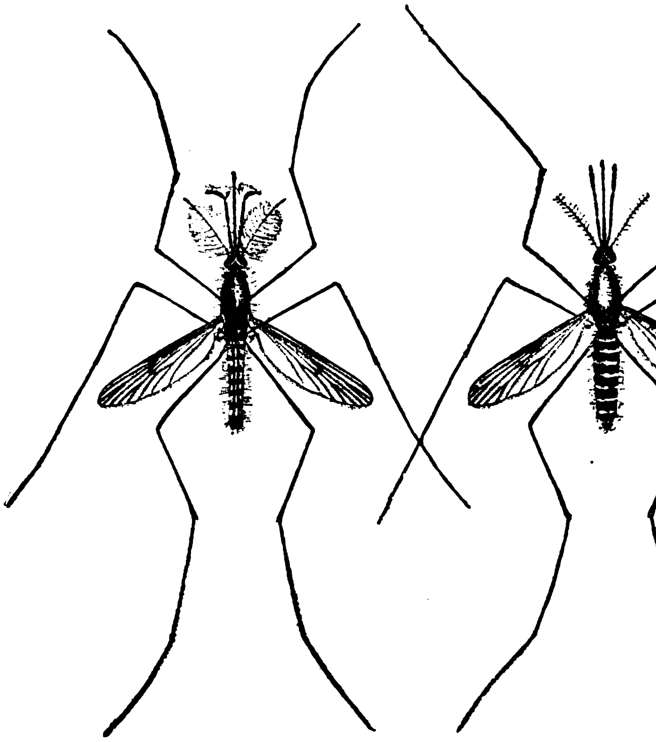


Fig. 14.
Anopheles maculipennis: male at left, female at right—enlarged. (From Ho
U. S. Dept. Agl., Div. Ent.)

It may be fair to say that it seems proved that witho
of the genus *Anopheles* there can be no transfer of ma
individual to another except by a direct transmission

sed individual to one that is healthy, but we cannot say
that it does not also require some specific surroundings or
ndition to make the transferred organism active.

isual in matters of this kind, there are rival claimants for
or of discovering the relation of the insect to the disease;
no part of my purpose to follow out what each of the many
ls who has studied this problem has contrbuted to its
The present state of our knowledge concerning the malarial
is so clearly and succinctly stated by Dr. L. O. Howard in
on mosquitoes that I quote in full:

of the malarial parasites are protozoans; that is to say,
-and not bacteria; that is to say, plants. In the human
ese protozoa inhabit the red blood corpuscles, and in the
ey go through a sporulating existence, which may continue
ely unless checked by quinine or some other way. In the
uscle the parasite appears as an amœbula, which gradually
ntil it nearly fills the interior of the corpuscle, digesting,
ly, the coloring matter of the blood and forming, as the
this digestion, pigment spots in its interior. On reaching
th the nucleus of the amœbula subdivides, each division
about itself a certain amount of protoplasm, until, instead
ngle amœbula, the corpuscle contains a large number of
The walls of the corpuscle then break and the spores are
into the blood serum. From a single infection, this sporula-
beration of the spores takes place practically simultaneously
ks the begining of the malarial spasm.

three different kinds of malaria, namely, that in which the
urs every two days, known as tertian malaria; that in which
recurs every three days, known as quartian malaria, and
e autumn fever, known as æstivo-autumnal fever, or tropical
-by far the most dangerous of the three—are by some
upposed to be caused by distinct species of parasites. This
ot held by other writers. But, at all events, the period of
ent of the sporulating stage of the organism differs in
time. As is very well known, it frequently happens that
rial fever or chill will recur every day. That means, in
alaria, that there has been a reinfection on one of the alter-
s, the development of the amœbulas being constant in point
one set sporulating twenty-four hours after the other set.
as this sporulation occurs, just as the spores are liberated
blood serum, just as the malarial spasm is about to begin,

that the administration of quinine is most affective. It se the spores when they are liberated, but appears to have effect upon the organism when it is enclosed in the red puscles.

"This sporulating development, each of the liberated tacking and entering new red corpuscles, may continue stated, indefinitely. But not all of the amœbulas underg velopment. Some of them, so long as they remain in body, apparently die and are digested by the leucocytes.

"When, however, these forms are taken from the hu even when a blood sample is simply placed under the mic examination, they undergo a development entirely differe sporulating form. Some of them grow large, others put filamentary arms, or flagella, as they are called, which se the body of the organism and fuse with those which d ellate. This is the true sexual generation of the parasit ellating forms representing the male sex and the receptiv female sex. The development up to this point will take where outside of the human body, in the stomach of mo the genus *Culex*, or, presumably, of other biting insects only in the stomachs of the genus *Anopheles*, so far as obs a further development takes place. After the fusing of with the female germs in the stomach of the Anopheles the fertilized organisms attach themselves to the walls of t penetrate the inner walls and locate themselves just unde muscular wall. They then rapidly increase in size until tually become five times as large as first. They are now zygotes. Clear spaces begin to appear on the surface. spaces are known as centromeres, and they are rapidly by minute, short, dark lines, which, when seen under a power of the microscope, are shown to be spindle-shaped c as blasts. These blasts rapidly increase in number until they fill the entire zygote, obscuring the centromeres, and condition of affairs is reached the zygote bursts and the liberated through the muscular wall of the stomach int cavity of the mosquito. They are active and penetrate the tissue of the salivary duct, and so into the proboscis quito, and, with the saliva or poison, they enter the bl next warm-blooded animal which the mosquito bites. It posed that the blasts enter the red corpuscles and the d re-begins at the stage where we took it up.

thus shown that the full devolpment of the malarial parasite ke place within the human body; that the Anopheles es are necessary secondary hosts; that the sexual generation rasite takes place only in mosquitoes of the genus Anopheles, er, that the old ideas of malaria from bad air (and of course *malaria* means bad air), swamp "miasma," and so on, are nds of those familiar with the subject of the biology of these of life completly overturned."

Health Board Reports.

y to the circular letter previously referred to, reports were rom 20 of the 21 counties, Salem alone making no reports. formal reports were received; but some of these covered n one jurisdiction, so that over 100 health districts were represented. My own collections, the collections made by erson, and the material received from other correspondents, rially to this number, so that it is fair to say that I have information concerning the occurrence of mosquitoes and lence of malaria from nearly 150 different points in the o present purpose would be served by presenting these re- detail, interesting as they are; but a brief summary and vill prove instructive.

98 official reports, 14 was the greatest number received one county, and 2 was the smallest, 3 counties having per to their credit. Seven counties present 18 reports that prevalent and cases are numerous. In a very few instances number of cases is emphasized. In one the reporting states: "I may say that during the summer and fall at er cent. of the people are affected. The particular type of the chronic form, thus showing that the disease remains stem; * * * but these people are so thoroughly ac- with the disease that they treat themselves. Yet their faces malarial cachexia." As the district represented by this a populous one, his report represents many hundred cases. unty reports no malaria at all; but from this I have only . The county is scantily populated, health conditions are good and, from my own observations, I believe that the really rare, if there is not an entire absence of cases origin- hin its limits. That persons suffering from malaria go

into the county for a longer or shorter period I know, contains several popular shore points.

In all, 28 jurisdictions report "no malaria" and 15 represented in these reports. In 5 counties all report occurrence of more or less malaria, and 6 is the greatest places in any one county where where it was said to be In the county sending 14 reports all show the occurre disease to a greater or less extent.

In general, it may be said that the malarial part of lies in the valleys of the Hackensack and Passaic and f along the Delaware river. Salt marsh districts are no unhealthy, but fresh water marshes are. The worst where the fresh and salt water swamps merge, and whe water marshes join the upland. Southern New Jersey the whole, quite free from malaria, and this exemption the majority of the highland regions along the Dela Trenton to the northern boundary of the State.

The reports show absolutely no correspondence betwee dance of mosquitoes and the occurence of malaria; and unexpected or unnatural. *Culex* may and does occur where malaria is an unknown disease, and, as *Culex*, fron is more likely to be observed than *Anopheles*, the reports the relative prevalence of insect and disease are not Yet a number of reporters seem to find a connection two, though a greater number declares to the contrary. that most of the reporters are, justifiably enough, igno distinctions between malaria carriers and mere nuisances positive conclusions can be safely based upon what is sai It does seem as if "no mosquitoes, no malaria" was gen bined, and malaria without mosquitoes is never reported.

As to the question whether one case of the disease i followed by others close by, there is the widest divergenc instances, cases were reported as "scattered," without ap nection between them; but there are also statements successive cases in the same family or district, that poi cidedly to some connection between them. As the ma now, no justifiable conclusions are possible one way or t

More than half of these sending reports expressed th willing to send in specimens if I would furnish bottles tions, and to all these I sent from 3 to 6 vials partly alcohol. Over 40 sent me one or more vials of specim

rent localities, and a little over 100 vials were received of 250 sent out. The results were interesting as matters ation of species, but they cannot be presented here in is enough to say that *Anopheles* was rare as compared , and from the worst malarial districts no *Anopheles* at all ed. On the other hand, the largest numbers of this type districts where malaria was practically non-existent.

lement the material received from the health boards, Mr. collected at a number of points in Essex, Union and Mor- s; Mr. Wm. P. Seal collected near Delair, in Camden Ir. C. W. Johnson collected near Riverton, Burlington d Mr. J. Turner Brakeley explored with great thorough- icinity of Bordentown, Burlington county, and of Laha- cean county. The remarkable collections made by Mr. ill be again referred to. My own collections were made st all counties south of Essex.

be as well to state in this connection my own conclusions ject of the relationship between *Anopheles* mosquitoes and ased upon the observations of the past season.

without question the published life cycle of the Plas- causing malarial symptoms and effects and the necessity *opheles* as an intermediate host. I am quite convinced ut the mosquito there can be no transfer of the malarial rom one individual to another; but I am not convinced wo factors—a malarial subject and an *Anopheles*—are *all* essary to cause an epidemic spread of the disease. Two Iiddlesex county are less than five miles apart, and *An*- qually common in both. In one town malaria is prevalent nic; in the other original cases are almost unknown. Yet ases from the one town go to the other for treatment. In se is stronger, for some patients work in the malarial town n the other. There is never a center of infection caused ersons. Furthermore, there is plenty of communication e two by rail and trolley roads, offering every facility for the disease. These are facts within my own knowledge.

case is a town in the pines with a hotel much frequented s, and where malarial patients from Camden and Phila- me every summer. Almost all the mosquitoes collected his hotel on several occasiones were *Anopheles punctipennis.* e of malaria has ever originated here or in the vicinity. ntrary, the patients that lodge there get well. I might

multiply instances, were it necesary, even to the ext
that malarial districts in a town contained fewer *Anoph*
in the same town where no cases occurred. To the
the *Anopheles* that bred in the malarial district did no
bring evidence tending to show the occurrence of
exempt districts, that could have bred only in the in

My conclusion is that there is a third factor necess
malaria, concerning which we are yet in the dark, an
do not care to make suggestions just now. I agree
and a patient whose blood contains the specific P
necessary; but they are not enough—the disease w
unless some other conditions are favorable.

How Mosquitoes Bite.

Common as mosquito bites are, few persons hav
operation of biting. Seen with a hand lens of mode
mouth parts of the mosquito seem to consist of a lon
tively stout proboscis or trunk, at the base of which is
palpi or mouth feelers if we have a *Culex*, or a pair
long as the beak itself if we have *Anopheles*. *Culex* se
ticular as to the place selected for biting, and will l
some time seeking a suitable spot—hence the aggra
which sometimes lasts a minute or two when at nigh
ing for the creature to alight and give you a chance at h
wastes no time, and alights without preliminary inve
do all species of *Culex* act with equal deliberation, fo
bite much more promptly than *pungens*. In any case
insect alights the proboscis is applied to the flesh, a
mediately a burning or piercing pain is felt. If th
undisturbed, it will be seen that the proboscis itself
into the wound, but that it bends slightly near the m
it supports at the base and tip a much more slender,
like structure, which is inserted deeply into the tiss
credibly short time the abdomen of the insect will b
and to show the tint of the blood absorbed until it
that it seems almost impossible for the creature to fl

If now the mosquito is smashed, it will be noted th
unusually thin or liquid and spreads over a larger s
equally large drop taken from a prick or cut directly c

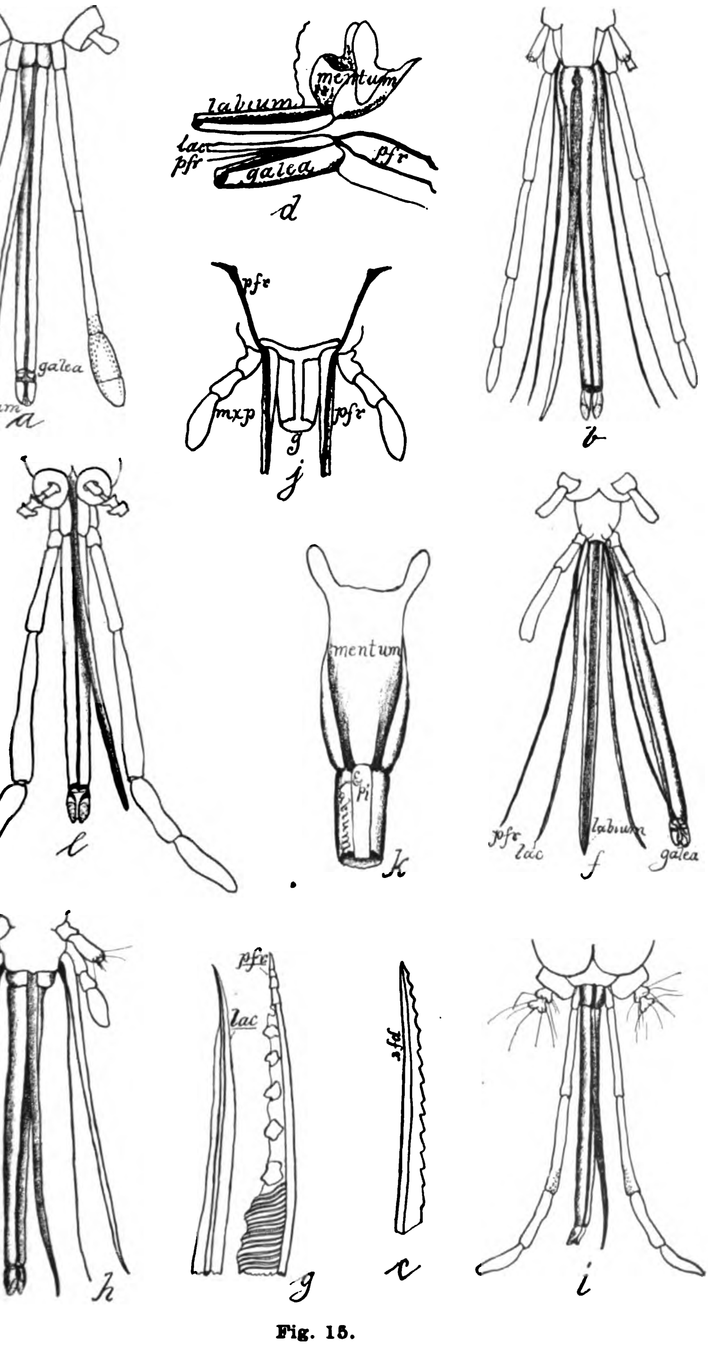


Fig. 15.

h parts of mosquitoes enlarged. *a*, *Anopheles punctipennis*; *b*, same, female; *c*, tip of one ets more magnified; *d*, shows how the parts issue from the head; *e*, *Psorophora ciliata*; *f*, le; *g*, tips of the lancets more magnified; *h*, *Culex pungens*; *i*, same, male; *j*, shows how parts are joined to the head; *k*, the mentum through which passes the œsophagus to join tube composed of the labium and epipharynx. Original.

rds, some change has taken place in its character and it much more fluid.

mine the mouth parts under a microscope of sufficient ind that the proboscis or beak is merely a shield or cover biting structures. It is jointed at the base and near the pen in front for its full length. The tip is not sharp or t soft and even a little spongy, utterly unfitted for punc-ular tissue. But the structures within this beak are quite d fully capable of piercing the toughest human hide that he State. They consist of five slender lancets, arranged rs at each side of a larger central organ. This central the labium or lower lip and is somewhat flattened, and channeled on the upper side. At its base is the opening llet or œsophagus, and it is joined to a somewhat horny structure, giving attachment to muscles that form the pumping arrangement, to bring food into the stomach. cets on each side represent parts of the maxillæ or lateral ng insects, and they are dissimilar in appearance. One

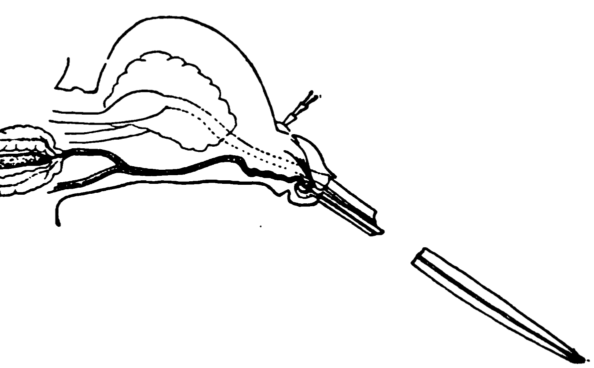


Fig. 16.

the head of *Culex*, showing location of poison gland at P. (After Mac-loskie, from Howard, "Mosquitoes." Copyright, McClure, Phillips & Co., by permission.)

der, almost cylindrical, and with a series of little teeth at other is more flattened and has the tip drawn in to a thin, , also with small teeth at one edge. These lateral lancets organs merely and assist the central organ or labium through the skin. The labium has a cover to the groove er surface; a very thin, flat piece, forming a continuous near its tip into the œsophagus. This tube is so fine that

the blood corpuscles, small as they are, cannot reac
it. At the base, and just before the œsophagus, is
small tube or duct coming from a salivary or pois
the moment when the central lancet gets through
quantity of this saliva is introduced into the wound
not the puncture, that causes the pain, for the sa
upon the blood, breaking up its corpuscles and thi
it may be readily absorbed by the insect.

It is often said that if you allow a mosquito to fi
bite will raise no swelling and will not pain much.
basis for this belief, for the poison introduced to liq
largely or entirely re-absorbed by the insect in maki
if the creature is killed after injecting the saliva,
theless exercises its specific effect, and inflammatio
must be dealt with by the body in its natural way.
duration of this process varies in the individual.

Some persons are very little affected, and a bite
only a brief sense of discomfort. Often these inc
mosquitoes never bite them. I have seen two of
lutely gorged with blood on the neck of a man wh
me such a tale in absolute good faith. He simply
bites. Other persons suffer severely, each individ
large swellings, resembling hives. I have seen su
with neck and face puffed up, suffering tortures, w
same party were merely annoyed. There is undo
ence in attractiveness among individuals, some b
frequently bitten than others; but no one is entire
as my experience goes. It is possible to become in
mosquito virus, so that the bites in time cause lit
but I have seen even natives in bad mosquito distri
in clouds of the little pests.

Nor is the virus exactly the same for each spec
fishermen along shore usually say that they don't
the salt-marsh species; but the little black fello
water swamps are "the very devil." The exact o
the inland inhabitant when he gets to the shore.

The difference between *Culex* and *Anopheles* is y
and, personally, I can always tell by which I h
Culex bothers me very little; *Anopheles* wakens me
est sleep, and the pain has a peculiar penetrating ch
described. I am aware that others have the opp

ith me the effect of a *Culex* bite usually disappears com-
few minutes, *Anopheles* leaves a little pustule that may
days afterward, if irritated. The same species may also,
rent weather conditions and when fasting, bite more pain-
hot weather, when the specimens have not fed for some
alivary secretion becomes acrid and, apparently, concen-
s to cause a more painful wound.

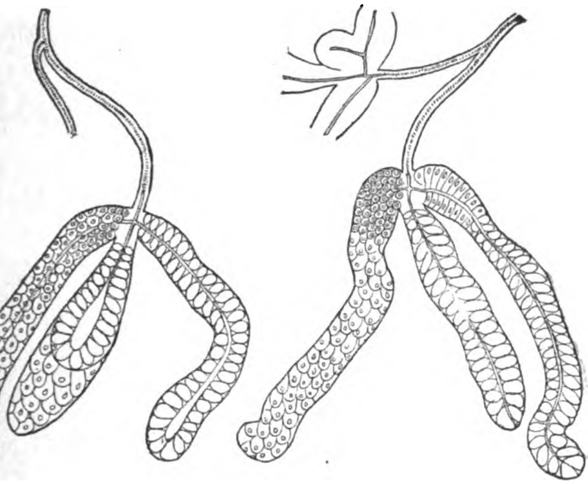


Fig. 17.

livary glands of *Culex* at right, *Anopheles* at left; greatly enlarged. (After Christophers, from Howard, "Mosquitoes" Copyright, McClure, Phillips & Co., by permission.)

s seen that a mosquito bite is not the same under all con-
at all times.

be added that the above general description applies to
s only. The mouth parts of the males have the same
pearance, except that the palpi are always larger and better
resembling golf sticks in some cases. Under the micro-
ch more important difference becomes apparent, and only
lancet remains. It is not actually impossible for a male
I have never seen one do so, nor have I ever caught a
swarms attacking me in the field.

Remedies.

As a mosquito bite exercises quite a different effect persons, so the matter of counter-irritants, or applic the pain, is also somewhat individual. For most per cation of a drop of strong ammonia water directly stop or materially lessen the pain. It is the remed has been used by many others with equal success.

Eucalyptol has no effect in my case, but acts well wi

Menthol is effective with many persons, and gives nearly all cases.

A drop of kerosene proves effective in some instanc help me.

A bit of raw onion rubbed over the bite is almost ammonia in my case, and with such others as have not nearly so conveniently carried about or applied.

The best method where the poisoning is not really the bite alone and pay no mental attention to it.

Repellants.

The cleanest and most effective repellant—*i. e.*, a will keep off mosquitoes—is oil of citronella. Thi from a grass, *Andropogon nardus*, primarily used in t of cheap grades of perfumery. The odor is not unp persons, is quite lasting, and absolutely keeps off all quitoes. Protected by this material, I have slept con hour on a seashore piazza, on an evening when eve driven indoors. I have used it since 1897 on all my and, no matter how large the swarm of mosquitoes in the salt or other marshes or in the woods, none e any protected part of the body. Many others have rial on my recommendation, and in all cases it has pr effective. It may be liberally applied on the hands a exposed parts of the body, but should be kept out of very hot days, or when perspiring freely, it causes a sensation on the skin of the face. So much superior thing else known to me that I do not consider it ne tion any of the many other mixtures and compoun seen and used.

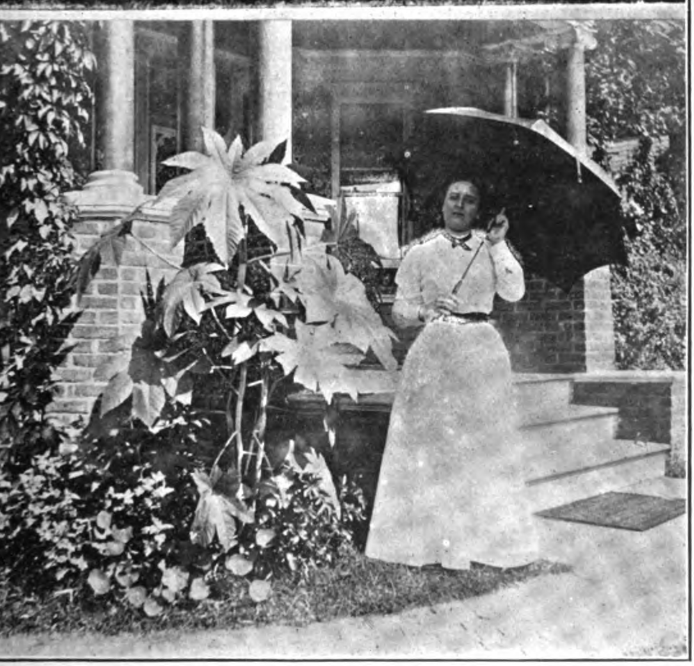


Fig. 18.

ws one of the cages used in studying the Cranberry Katydids; lower half shows one of
plants at porch corner in early August. From original photos.

s certain species of mosquitoes will make a determined into the house through the wire-netting screens. Not all his, nor do the forms that have the habit do it at all I have watched a screen for several minutes, and have en after specimen work its way through into the room. the screen lightly with a brush dipped in kerosene put an and final stop to this practice. Not another specimen gh the treated screen, while through the other the proces-ued uninterruptedly until I had satisfied myself that the the first screen was not due to some outside cause. Then ne second, also with equally satisfactory results.
an plants have been said to exercise a repellant effect, and ay that they may not do so in some places and against es; but the New Brunswick brands of the New Jersey not mind them in the least. I have always had a little astor bean in my garden, and, to test its effect on mos-lanted three groups in 1901. One large group was about n the corner of my porch; a second was on the opposite arden; the third was at the corner of the stoop-bench, over-Sitting on this bench, the back rested against the bean he leaves overhung the head. Yet this was a little the uito corner of the porch throughout the summer. While nue to plant castor beans, it will be because I like the not because of any expected effect on mosquitoes.

How Long do Mosquitoes Live?

present, our answer to this question must be, "I don't For the hibernating species, we know, of course, that they ter, and, for a time, at least, the preceding fall and suc-ing, until they have succeeded in laying their supply of he *Anopheles*, we know that they cannot transmit malaria bite twice, at least, and live for several days between rmit the development of the Plasmodia. Of the *Culex*) *tæniata*, which carries yellow fever, we know the same we know that individuals have been kept in captivity for ble time.
does not answer the question for the other species during r, under normal out-door conditions. There is no reason hat the females are not sexually mature when they emerge upa, and that impregnation does not occur promptly. In

fact, there is every reason to believe that copulatio
soon, and that eggs may be laid a day or two therea
eral rule, though by no means universal, that wh
provided for the continuation of the species, its
reason for its life is gone, and it therefore dies. O
insects normally short lived often survive for co
when there is no opportunity to lay eggs, life holdi
rently, until its continuance is assured.

Based on these considerations, it would seem th
of an individual mosquito is an undetermined
favorable seasons, when there is plenty of moistur
promptly laid, a week might measure the period
drought individuals might live as much longer as w
if for any other reason eggs could not be deposi
unusually prolonged. This point applies especia
mosquito, which, breeding only in salt water, yet s
localities miles away from any possible breeding-pl
mens would live for some time—two or three we
this is indicated by the fact that in places where m
rarely and do not breed naturally, the pest remai
or ten days, and then gradually disappears.

This is a point that requires further observatio
for of most of the species we know nothing definit

THE SPECIES OF CULEX.

Heretofore facts of general application to all mos
general class of species have been brought out, and
sary now to speak more particularly concerning t
and a few of the species. Other genera occur, and
later, but the two best-represented genera are *Culex*

The genus *Culex* contains all the common, eve
that occur almost everywhere, more or less abund
the State. They are moderate or small in size, w
awkwardly-long, legs, unspotted wings, and, in the
palpi or mouth feelers. The great majority of al
seen by the average individual are species of *Culex*.
species or kind are to be found in New Jersey I c
have bred seven species during the past season, a
least three, if not four more, so it is certain that
dozen, at any rate.

iffer much in their habits, the places selected for breeding
ther characters. Some are practically confined to the
are rarely found in houses. Even when the woods come
few hundred feet of the house they do not seem to care
ving them. Such species breed in springs, in road pools
wampy, cold ground, in spring-fed ditches and the like.
ed anywhere—in rain barrels, road puddles, even in cess-
ich are usually house mosquitoes, and form the bulk of the

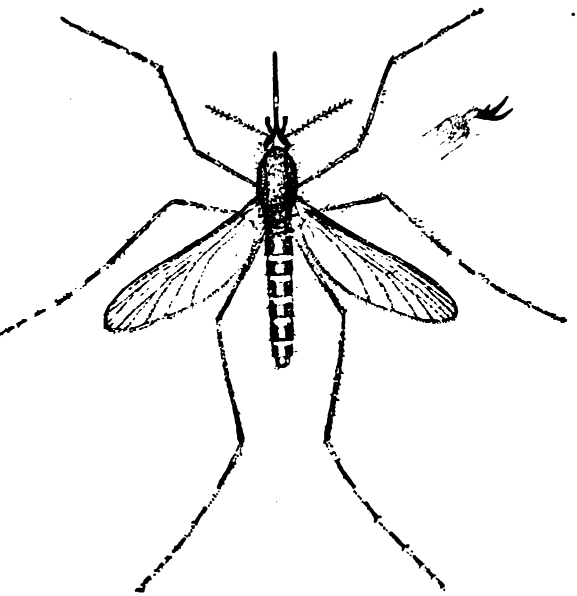


Fig. 20.
ulex sollicitans—the salt marsh mosquito: female, enlarged; toothed tarsal claw at right, yet more enlarged. (From Howard, Bull 25, n. s., U. S. Dept. Agl., Div. Ent.)

d examples that occur in the inland towns. To show how
ey breed, it may be said that in the botanical laboratory a
containing plant specimens in water was found to be
with wrigglers. In one of the College fraternity houses the
the shower bath became choked, and a little puddle re-
n the depressed floor area, awaiting the leisure of the
o make repairs. Long before he came the little puddle was
with larvæ, and prompt measures became necessary. In
is no place so unlikely that it may not serve as a breeding

place for some *Culex*, provided only there is water ;
tin can or a hollow in a tree trunk—all are equally a

Yet another species breeds only in salt water, thou
if not all the others, are confined to that which is fr

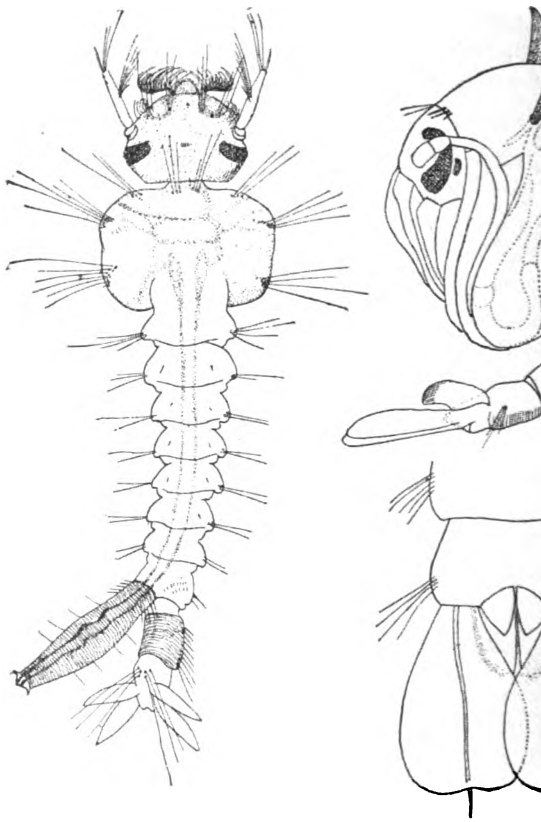


Fig. 21.
Larva and pupa of *Culex pungens*, enlarged ; with anal flaps more enlarged. (From Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

I have several times referred to "wrigglers" as
and this term is especially appropriate for those of
Mosquito larvæ are odd-looking creatures, with large
body, a slender abdomen, and a long or short tube-l
the penultimate segment, through which it gets it
Figure 21 illustrates the appearance of such a larva.
altogether in the water, the larva is dependent for its s

t it can get from above the water surface; hence this anal tube is a very important structural character. It varies in nt species, but always has essentially the same functions. al position of a mosquito larva in the water is head down, at the surface. When disturbed, it gives a quick, jerky sends it to the bottom, where it remains until matters quiet ntil the lack of air forces it to the surface. Then it makes by a series of jerky or wriggling movements that have he common name. The mouth parts consist largely of a ushes, which are kept in almost constant motion, serving a means of locomotion, and partly to create a current which the mouth opening the microscopic organisms upon which Mosquito larvæ are in their natural functions scavengers, mission is to do away with some of the forms of organic vould otherwise cause putrid conditions. There is, conse- good good reason for the existence of the mosquito, and, lt is often a nuisance, the larva has a claim to our consid-

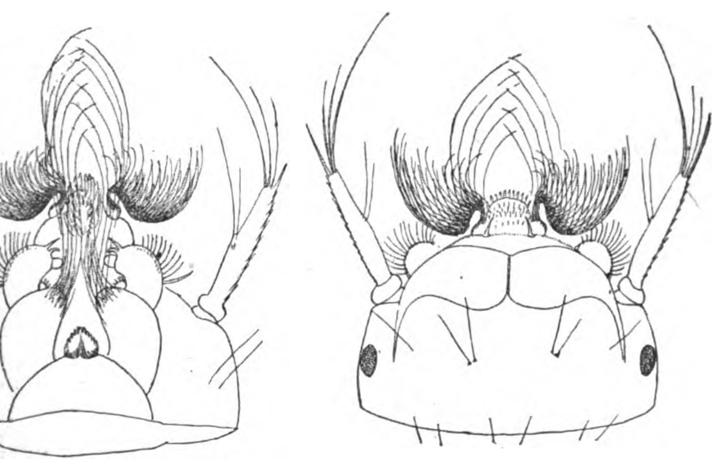


Fig. 22.

rva of *Culex pungens*: from below at left, from above at right; greatly enlarged. (From Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

he sides of the larva or wriggler come little tufts or groups or spines, which are more or less branched or otherwise so as to form convenient means of recognizing the different

Life History.

In a general way, all the species of *Culex* have the
tory. The winter is, or is believed to be, passed in th
Of some we know that this is so; concerning others it i
belief, based upon general principles. When the warm
in fairly, the few examples that have succeeded in p
through the dangers of the winter seek a place to ov
the females live over from the year before, and they ma
sonable demands; any bit of water in which there are
enemies will answer.

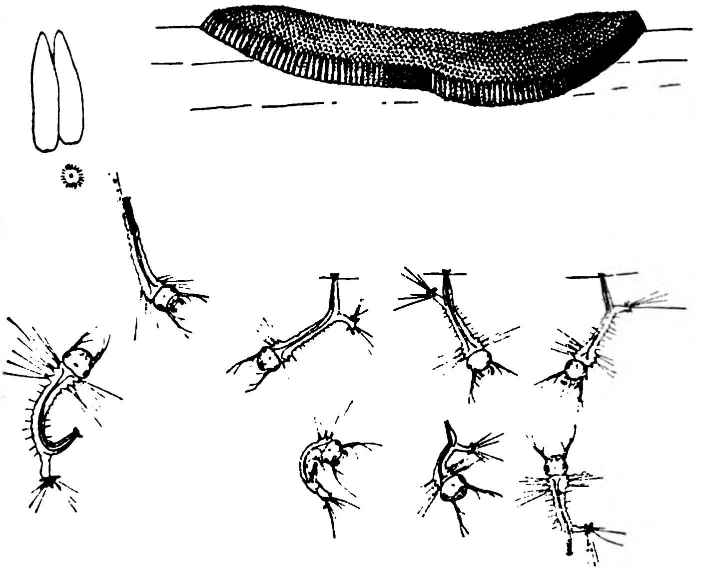


Fig. 23.
Culex pungens: egg mass, with enlarged eggs at left and young larvæ bel
(From Howard, Bull. 25, n. s., U. S Dept. Agl., Div. Ent.)

Eggs are laid on the surface in somewhat oval, co
masses, loosely termed "boats," each of which is the p
female, and contains from 200 to 400 eggs. A boat of
about three-sixteenths of an inch long, and rather more
wide, but is not regular in outline. Individual eggs
(three one-hundredths) of an inch in length, slender, a
at the tip and broader at the base. In color the mass is
tending to blackish as it grows older. The egg-stage is
varying a little as the temperature is high or low. It

ur hours to three or four days, and then the young emerge base or broad end of the egg, which rests upon the surface ter. The larvæ are thus brought naturally into the medium they are to live, and the period of this larval-life is also matter of temperature. In midsummer, when the water is the food-supply abundant, from six to eight days is enough ull growth, with a minimum of ten days for the entire life Then full grown, the larva changes to a pupa, which is a bull-headed creature; the head and thorax with its wing ning an enlarged structure, the abdomen slender and curved terminating in two broad, somewhat leaf-like appendages. the place where the thorax and abdomen join, there is a horns," or slender, curved tubes, through which the pupa and these rest normally at the surface. The pupa is lighter r, and, under ordinary conditions, floats, requiring no effort t in place. If disturbed, it moves down and away by ir-erky motions; but rises rapidly to the top as soon as these

gth of the pupal-stage also varies, according to the season, than twenty-four hours to several days, and the species s vary in this particular.

general statements apply to all the species of *Culex*, so far as and may be assumed for those forms hereafter mentioned, here otherwise specified.

be added that breeding continues far into the fall. Mr. has taken larvæ and pupæ out of pools that have been ice-and I have taken them from a pail that had been covered quarter inch ice, breeding *pungens* from them.

THE SALT-MARSH MOSQUITO.

Culex sollicitans Wlk.

the common species that lives along the seashore and marshes along the coast. It often occurs in swarms suffi-make life a burden, and has absolutely depopulated and e abandonment of otherwise well-situated seashore resorts or It is easily recognized by its generally gray color, the legs tly banded with white, and the beak or proboscis with a hite band at its middle. The sides of the body beneath the black, and this is an easily-noted character. The abdomen with yellowish-white scales, and a line of such scales runs

down the middle; so, with all these points, which are i in any other New Jersey species, there should be no recognizing this mosquito wherever it may be found, a inland. I say inland, because, though it breeds only al is shown in the next section, and the larva occurs now adult is by no means so limited. It is by far the m species throughout South Jersey, and at certain season one. It extends from the coast to the Delaware river, phia, and even further north in Camden county. It ex along all the larger streams and over the meadows at th along the valley of the Hackensack and Passaic river dominant species at Newark and Elizabeth, and at tim nant species at New Brunswick. It extends to the base or Watchung mountains, but does not get into them Yet it has been taken at Morristown, and is not uncom son. I have not had it from Bound Brook, Somervi north and west of that region, and it is usually rare i regions, even in the southern counties. Almost invariab ties where mosquitoes were said to be rare or wanting emption to the absence of this species. Invariably, reported that mosquitoes were sometimes bad, but c come, the culprit turned out to be this form. I drove pines for miles several times this season, when the car filled with mosquitoes, and all were *sollicitans!* On cr twenty miles from shore, not in one place only, but in them, the millions of specimens were all of this one t evening in July I spent half an hour on the platform o station of the Pennsylvania railroad, waiting for a trai quitoes were in such swarms that no one had more im than slapping at them, and all were this form. For more the only species that I could find around my porch ing was this very one! More than half of all the speci from health officers in South Jersey are of this species.

Briefly stated, this is *the* Jersey mosquito, and were it existence over 60 per cent. of all the specimens in the S accounted for. Indeed, in some regions this is practi species, so that exemption from its visits would mean a absence of mosquitoes. In most of the others the resi so small as to be either unnoticed or to cause but a t venience.

The economic importance of the species is, therefore, the first question must be as to how and where it breed

BREEDING PLACES.

ning the breeding-places of this seashore mosquito, the ex-
of the season seems to prove positively that it is confined to
or salt water. I have hunted the larvæ in fresh-water dis-
re adult females occurred by the million, and failed abso-
find even a single specimen. In the pines and about cran-
s, where without citronella it would have been torture to
gathered larvæ in numbers, but never of this species. In
ing-pails at New Brunswick every species that was found
s bred except—*sollicitans*. On the shores of Barnegat bay,
ws covered with fresh water in pools and puddles, where it
s if *sollicitans* was the only species, and was certainly the
that occurred in swarms, larvæ were found in great abun-
ut never *sollicitans!* So plentiful were the larvæ that ran-
ings with a two-ounce beaker would give from a dozen to
more at each dip, but none were *sollicitans*. At Anglesea,
gathered in larvæ of *sollicitans* from every brackish puddle
them, none of this species could be found in fresh water.
neadows near Elizabethport Mr. Dickerson spent parts of
s hunting mosquito larvæ. He found them, of course; but
he got into distinctly-salty water did he get *sollicitans*. It
nost incredible that the immense swarms that covered miles
Jersey—all females—should die without reproducing their
le water in abundance was everywhere. Yet such is un-
the fact, for neither I nor any of those who have collected
h me this season has found a *sollicitans* larva in fresh water.
kish and salt water they occurred everywhere. At several
ng shore I collected at different times during the season,
ever I found a salt-water puddle in a road, in a mud flat, or
y-filled ditch, there were larvæ in swarms. Here there was
lty in finding male adults, and here was oviously the home
cies. Not only in puddles and ditches, of course; there
where on this coast region immense flats, which are covered
nusually high tides or during storms, and when these tides
ery hollow and hole is filled with sea water, which evapo-
slowly. Here are the ideal conditions, and here these
re bred that are afterward carried miles away. The water
s, and only the deeper holes remain—absolutely crowded
glers. A shower or a rainy day brings a fresh supply of
ich becomes salty from the sediment on the surface or from

the concentrated liquid remaining, and favorable bree
are again restored. In this way was bred the immens
during 1901 drove visitors from many a point and
annoyance, if not positive suffering, to the permanen

So that it is salty, it does not seem to matter mu
how salty the water may be. During the latter part
lected a lot of larvæ of all sizes from various puddl
and carried them alive, in the water in which they ha
Brunswick. At the same time I handed a bottle of
Dr. E. G. Love, of New York City—a chemist by pr
tomologist by inclination—and asked him to determ
age of salt as compared with sea water. Another sam
to Mr. John P. Street, one of the chemists at the
tion, with the same request.

Mr. Street reported the salt in the sample analyzed
per cent., compared with sea water at 100 per cent.
made it 123.8 per cent. on the same basis. As th
from different pools, the percentages are slightly diff
show a salt content almost one-fourth greater than se
they do not need this large quantity is shown by a
ments made by Dr. Love later in the season, on whic
enough to report to me as follows, the account being s
cept where quoted: Larvæ were taken August 3d, 19
pool on a salt meadow at Miller's Place, Long Island.
has underground springs of fresh water, so that the n
was more or less diluted. The pool was left very ne
there being sometimes barely enough water present to
in a moistened condition, and not sufficient to enabl
about. The larvæ were all above half-grown, some
and some adults emerged four days afterward.

"My object in the experiments was to determine h
lution of salt the larvæ of this species could stand, an
figures of salinity are calculated on the basis of th
being 100.

"The different solutions were prepared by adding
ties of a salt solution to known quantities of the origin
salinity of the solutions was afterward determined by
original water and the salt solution used, and a simp
The analyses were not made until after the conclu
periment, and it was not known that the water in w

en had less than half the salt content of normal sea water. ea water was assumed in planning the experiments.

irst three solutions which I used, and upon which I mainly , were, therefore, much weaker than I supposed, and the nts made with the first and second really added nothing to already knew, inasmuch as they were not as strong as the om Anglesea. Between the strongest of these and the next stronger) there is, unfortunately, quite a gap. I will give igures as I have them, and you can make such use of the tained as you wish:

original water contained 44.5 per cent., and I call it No. 1.

2 contained 71.6 per cent. of sea water.

3 contained 97 per cent. of sea water.

ese three the larvæ were very active. Several pupated on On the 8th many had emerged, and within a few days all so.

comes the Anglesea water with 123.8 per cent.=No. 4.

5 contained 143.3 per cent.

e was no marked difference between this lot and those in lutions.

6 contained 254.4 per cent. It is unfortunate that there t least one solution between this and No. 5. At the same matter of practical interest, the experiments should have le on the eggs and young larvæ, and an effort made to e what percentage of eggs, hatching, survive through the ages to pupation. It seems very probable that the solu- ch do not kill the half-grown larvæ would have a much ructive action on the larvæ in the early stages.

arvæ placed in solution No. 6 became very sluggish at once dead within a few hours. As the gravity of the solutions re on) increased, the larvæ were unable, apparently, to a perpendicular position in the water, but lay upon the This was probably due in part, and it may be entirely, to hat the water was killing them and they had not much although they moved about more or less. The stronger had, practically, the same effect as No. 6, but, naturally ength of the solutions increased, the larvæ died sooner. One about six times stronger than sea water, killed them in two ours.

of the larvæ were removed from the original water and Croton, in which they flourished as well as in the original

water. Another lot was placed in distilled water through a dish of the same to remove any particle carried with the larvæ in the first skimming. Th this as in any of the lighter saline waters, but t quite different and undoubtedly would be if the young.

"I also put a lot of the larvæ and another lo sponges. There seems to be no difficulty in the pu this short stage under these circumstances, but the to pupate."

The latter observation makes it almost certain can reach the pupal stage the water in the puddl live may evaporate completely if only the surface

The account also shows that under certain co occur in tide water, which is certainly not the rul rise and fall here, as Dr. Love informs me, was inches. About as good places for larvæ as can b salt meadow areas where the railroad companies h for their embankments and dams. These areas fo which persist from one spring or storm-tide to forth mosquitoes continuously.

Ordinarily, all areas over which the tide ebbs a free from mosquito larvæ. In such areas fish com fiddler crabs live in the mud and a variety of sh the like find a permanent home. Here no mosqui tain themselves, even in pools, which are never low water. Little fish gather here as the tide reced could survive for an instant.

It is again emphasized that only in salty water, tions such as I have described, can this species br ance of this limitation will appear when the questi the insect comes up; for it both limits and direc the work to be done.

I have a large lot of notes and observations breeding grounds along shore; but there is no detail nor necessity for the purposes of this report.

How Do the Insects Spread?

now shown that *Culex sollicitans* is the most common and
ie species throughout a large part of the State, and also
eeds only in salt water, the question naturally arises, how
ects get so far from the breeding places, and what becomes
hen they are twenty to thirty miles away from the nearest
e their larvæ may live? Further, it should be determined
e coming in is continuous or intermittent—dependent upon
sary combination of meteorological conditions or only upon
of the insects themselves. It would be too much to claim
questions can be definitely answered as the result of the
this year; but the probabilities have been outlined and the
ture investigation have been fairly well indicated. I may
at up to the present season I had not believed in any
or long mosquito journeys, and Dr. Howard quotes me;
t season's experience convinces me that I error.
all we may eliminate the human element from a
tandpoint. Nothing that man has done or favors
of the insects, though it may check or it. Dr.
inks railroad trains are responsible for some carrying from
to another, and he is undoubtedly right to the general
. A few female *C. pungens* or other breeders in fresh
ied from a coast city to the Catskills, might easily start a
a series of colonies where none were before. But this
pply to our shore species. A dozen specimens, carried from
y to Somerville, would be only a dozen specimens, and
ain that many only, since they could not breed when they
Furthermore, there are a large number of trains daily
ersey City, Newark and Somerville, and if trains carried
numbers Somerville would be pretty well supplied with
s, whereas, in fact, not a single example has been found
ng 1901. And it has not been because there were no *solli-*
ewark or in the trains at that point. *Sollicitans* is not by
a house mosquito, and while it will get in occasionally,
undantly when there are many of them about, it is easily
nd will get out of its own accord if given the opportunity.
the past summer I have been on trains running from the
Philadelphia a great number of times, and almost invaria-
crossing the meadows, a number of mosquitoes came into
But as we proceeded they made their way out again until,

long before we were anywhere near Camden, not a sp
On the trains from Toms River, which I boarded
New Lisbon, Hanover Station or Browns Mills, the
few *sollicitans;* but most of those disappeared b
Pemberton, and none ever got to Mount Holly wi
tion. I have said that it is not a house mosqui
and for that I have abundant evidence. Not a
my house at New Brunswick, while *sollicitans* was
only form, though the garden was full of them, and
the porch meant using some repellant to secure c
not one of the specimens that I saw indoors during
was of this species.

Of the house captures sent me by Mr. Brakele
not one was *sollicitans*, though there were "bushe
many yards away. I had some of my board of
send me separately, specimens taken in rooms and
outdoors and it was rare that the salt species occu
bottle. There are plenty of them in the houses
their breeding places, because they are everywher
but even at Anglesea, where *sollicitans* simply swar
porch, the only species in my room was *pungens*.

A ride from Atlantic City to Somers Point duri
son is an interesting experience. None are in the
nor, if there is any wind at all, during the ride acr
but at Pleasantville they begin to come in, and as
along the edge of the meadows they increase in num
Point is reached. On the return trip the rever
encountered. Most of the specimens that entered
coming trip have made their way out; but as soon
and stirs them up they begin coming in again unt
meadow is reached. While crossing this most of
and the train reaches Atlantic City practically free

Having eliminated the human element, there rema
tion voluntary flight on the part of the insects and
transport by high winds. The latter alternative m
nated, for it is the universal experience that the ins
a strong wind, or if they do, they keep to shelter
and do not rise high enough to be caught and car
gales. In fact, under ordinary conditions, volunta
high above the surface, and this seems reasonable

habits of the species. All the food occurs near the

ects, then, migrate voluntarily? It would be too much ut, at least, it is certain that the males take no part in he females certainly do place themselves in a position to a good breeze for long distances. Damp or wet weather red, or may even drive the insects out of their native l events when the cause acts it affects multitudes of that form swarms of great extent. So far as known, occur only during the night. It is not a wind from a tion that is the inspiring cause, for swarms are carried often as inland, if the statements of captains of coasters boats can be believed. Fifteen miles out they have hing fleet at anchor and invaded every vessel; to that ositive statement of two of the captains who were seen aces and separate times, both narrating their experiences tion at my request. It is common knowledge that, negat bay is ordinarily quite free from them, occasionally breeze will bring clouds to the center or quite across to sorts. A land breeze is therefore dreaded, because it quitoes," while a sea breeze, on the contrary, "drives " or at least discourages flight, for specimens remain way from the immediate beach.

mden county, is about forty miles from the sea, and re- inquiries that mosquitoes were very plentiful at times; me with a south wind from the shore and that their ended on the winds holding true. A vial of specimens n one of these shore winds brought the insects proved *ns.*

Lohsen, of Belford, Monmouth county, wrote me on follows: "I am convinced that the mosquito is migra- ve them most after a long southerly or southwesterly s after a northerly or easterly wind. One case in point: e had no mosquitoes) I heard them in the air like bees t could not see them. They must have settled during next day we were almost smothered with them. Then them out in the bay in years gone by, everything they on being alive with them. It was only last night that s, who work four to five miles from shore, reported them ff shore. They also reported speaking to a party on a anchored near Romer Shoals, that they [mosquitoes]

invaded their yacht during the night previous a
possible."

Dr. W. G. Chamberlain, of New Egypt, Ocea
about twenty miles from shore, sent me this speci
my letter advising him of that fact he states tha
thought these mosquitoes were from the shore fo
They don't bother us unless we have strong south
at night for several days at a time; (2) they are a

I might cite other reports without adding any
content myself with two cases that came more par
own observation. Early in spring I spent a few
hunting mosquitoes; at that time *sollicitans* was a
the larvæ taken were of this species. At short in
received specimens captured in the woods and c
bogs or dams. None of these was complained
abundant. But suddenly, after a few days of sout
summer, came a bottle of *sollicitans* with word th
bushel of them if need be, and loud complaints t
door work a burden.

At about the same time, or a little later, the Brow
invaded in the same way, and when on August 19t
J. J. White from New Lisbon to his bogs near
distance of about six miles, *sollicitans* appeared in
we got well within the pines. Mr. White and his
C. White, agreed that two weeks previously no
existed. I have already recorded the fact that I
this species anywhere about the bogs where t
numerous.

As the result of my observations, supplemente
tion obtained from a large number of individua
Culex sollicitans, the salt marsh mosquito, is to an
using that word rather loosely, for it is not a real r
direction of flight is not within its control, but
wind; but the impulse to rise in masses and fl
is in the insect, and in so far as there is an obedie
the flight is a voluntary one. The distance to wh
extends is not yet definitely determined; 40
times; 20 miles very commonly. The specime
delphia may have come up the Delaware river a
bred much nearer the city than the distances abo

We do not yet know what factors determine t

rounds nor how long the insects remain afloat. A five or eeze might carry them a long distance during the night. It lso, at least, interesting to know whether, after one flight, warm ever started on another. In fact, there is a series s yet to be worked out concerning this common species. lace to add that the conclusions above stated apply only *llicitans*, and may be entirely inapplicable to any other

THE HOUSE MOSQUITO.

Culex pungens Wied.

cies is a close ally of the European *Culex pipiens* L., and he same species ; but as this matter is at present somewhat the name used by Dr. Howard is employed here.

g it the "house mosquito" I do not mean to assert that ed to an indoor habit ; simply that the great majority of cimens received as taken indoors or observed by myself le to this species. It is also the only form which I have in the rooms or cellar during the winter. In warmed ouses it continues active all winter and may even breed. n bitten, in Philadelphia and New York hotels, in January the culprit, when hunted down, was always *pungens*.

ficult to describe this insect because it has no strongly-eculiarities. It is of medium size, dirty-clay yellow in or, and has the abdomen obscurely banded. The legs are d, and the beak has no white ring or band. It varies both in size and in general color, some specimens being of y light yellow. Examples taken by Mr. Brakeley with the *nopheles* in his cellar, were almost cream-colored, so light e they. It is probable that age has something to do with hat the darker examples are such as have lived some time. he species referred to on a previous page as breeding in all nexpected places, citing the botanical laboratory and the r from a shower bath as examples. Its larvæ have been in a neglected aquarium in which there were no fish, and and other localities of similar degree. Most of the mosed in my back-yard pails were of this species, and Mr. ent me a great mass of them as wrigglers taken from a . Mr. Dickerson found the larvæ in sunken lots in Newark, y were dumping garbage, and in an old cistern at Morris-r. M. S. Crane found the larvæ in cesspools and in liquid

manure, and Mr. Brakeley found them in filthy
receiving city sewage. There is no place so nasty
will not live in it, provided only that it must be li
of the pools in which they occurred the surface was
a greasy scum that it seemed almost incredible th
tube could pierce it.

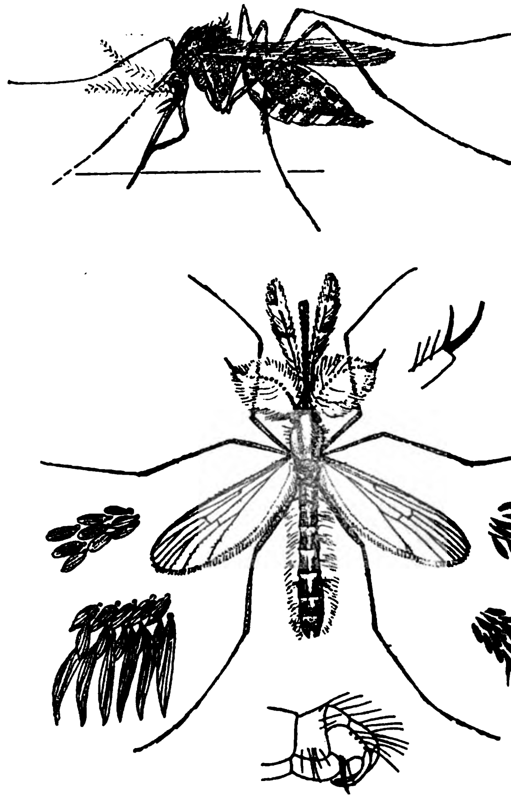


Fig. 24.
Culex pungens: female, with distended abdomen, above, ma
enlarged; structural details of male yet more enlarg
(From Howard, Bull. 25, n. s., U. S.
Dept. Agl., Div. Ent)

The larvæ of this species are shown at Fig. 21, and
by their generally white color and the rather long, stou
which is a little enlarged or thickened in the middl
where the larvæ have been found, it should be adde
not been found by me in woodland springs nor in cold

sollicitans, this is the most common species occurring in but breeds under altogether different conditions. The egg pupa are as has been already described, and are repre- Figs. 21 and 23.

ing on the indoor habit of this species, Mr. Brakeley made observations on the specimens seeking shelter in an out- Bordentown. During July 137 specimens were taken, all nd 24 was the greatest number found on any one day. ugust 271 examples occurred, and 43 on August 18th was st number found on any one day. Both sexes were taken, s in great excess, and they did not breed in the outhouse s positively determined. They simply resorted to the place , and it affords a good illustration of the domestic habits cies.

Other Species of Culex.

species of *Culex*, other than the two already mentioned at cur in the State, but not in numbers sufficient to make s obtrusive. Possibly *C. cantans* may be an exception to nent, and this resembles a very stout, more bristly *pungens*. d it in pails and have collected it at South Orange.

nfinis has been sent me in the larval stage by Mr. Seal, of d I received a few adults from Lahaway. I think there me in bottles from some of the health officers, but this is mon species and seems to be confined to woodland locali- as a banded beak and is a large, unusually dark species.

rritans is a small species, which looks blacker than the d has slender, black legs. The abdomen is narrowly white- the posterior edges of the segments, the other species hav- ite bands at the base. The larva is a white wriggler, with quare head, a long, slender breathing tube, and this I have nly in meadow puddles or in running water. It is a much ate looking larva than that of *pungens*. The adult is com- gh, but seems not to be a house mosquito. I have not s such myself, nor has it been sent in to me by any corres- mong the indoor captures.

imulans. This is a brown or blackish mosquito of mod- with the tarsal segments white-marked at base. The abdo- her conspicuously marked with white bands, which tend to complete, and these characters indicate the species. The e been found on the Elizabethport meadows, at Anglesea and

near Newark—always in fresh water and seeming to jo
places of *sollicitans*. In fact, at Elizabethport, bot
breed in the same pools, as the water becomes salty
or fresh by the constant addition of stream-water comi
never found this as a house mosquito, and it is not on
counted as troublesome. It does not breed so genera

Culex canadensis has the legs banded, the tips and
foot-joint being narrowly white. This is a woods m
exclusively, and I have it only from the pine distric
is very dark, almost black in color and breeds in wo

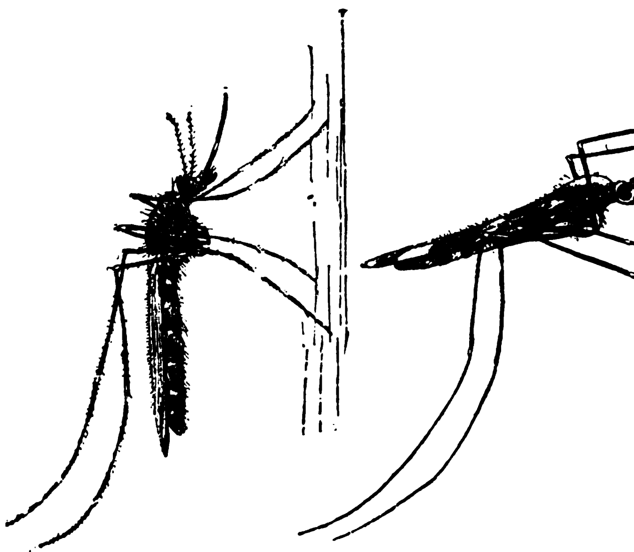


Fig. 25.
Resting positions of *Culex* (at left) and *Anopheles* (at right), enlarged. (Fr
n. s., U. S. Dept. Agl., Div. Ent.)

road puddles and ditches—always in cold water, ap
Brakeley informs me that the wrigglers were yet ac
first week of November, and that on the 10th he fo
examples. This is also an innoxious mosquito, which
as taken in the house anywhere. It bites readily e
haunts are invaded, but will not seek prey even a sh

Culex tæniorhynchus is like *sollicitans*, but does not h
whitish scales down the middle of the abdomen. I
fresh-water pools near the seashore, and I have it from

This ends the list of named forms that have been b

I have one or two others, but it has been impossible to
em.

taken several species which are not known to me in the
They are comparatively rare and need not be con-
the economic standpoint at all. So far as named they
riatus, *Culex impiger* and *Culex perturbans*.

THE SPECIES OF ANOPHELES.

ed with the mosquitoes of the genus *Culex*, the species of
larger, more slightly built, with longer, more sprawley

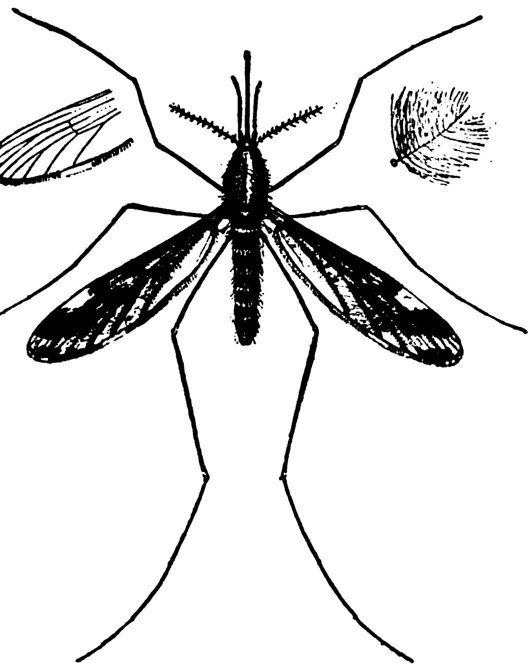


Fig. 26.

opheles punctipennis: females, with male antenna at right and
wing tip, showing venation at left, enlarged. (From
Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

rower, longer wings, which are laid closely over the back
The latter are also more or less spotted with black,
mon species having them very prominently ornamented.
y speaking, the head seems narrower and the proboscis
which is due to the fact that the palpi or mouth feelers

are as long as the beak itself and give it greater pro
species occur in New Jersey, of which *A. punctipenn*
best marked and most common. Unless otherwis
general references to *Anopheles* or malarial mosq
taken as intended for this species.

Anopheles maculipennis is decidedly smaller and
only two obscure, blackish spots on each. It is an in
species, easily overlooked as a member of this gen
less abundant than *punctipennis*, take the State as
locally it seems to outnumber the other species.

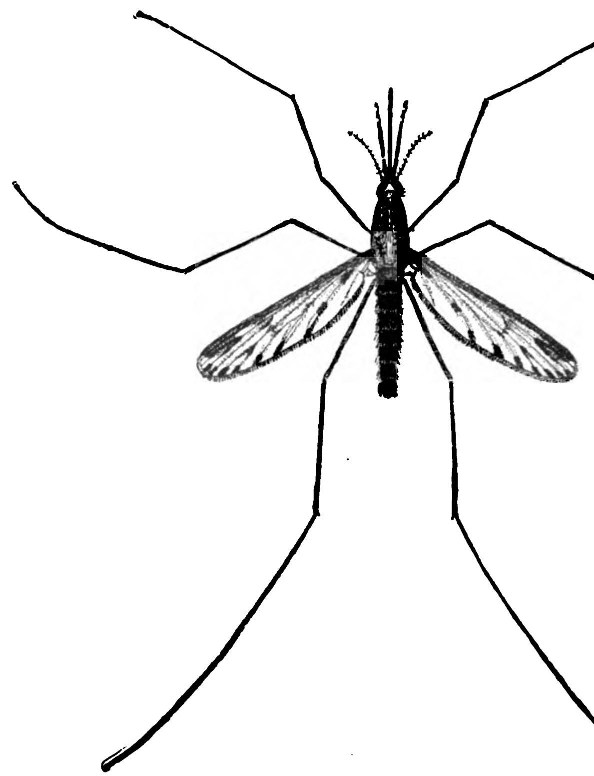


Fig. 27.
Anopheles crucians, female, enlarged. (From Howard, Bull. 25, n
Agl., Div. Ent.)

Anopheles crucians is very rare in New Jersey, onl
from Ocean county having come into my hands
common in Delaware and southward, and I have lit

locally in some numbers in our State when the Cape May thoroughly explored.*

the characters above mentioned, the species of *Anopheles* y recognizable when at rest by the fact that the head points rface upon which they alight, between the anterior and ir of legs, and the body extends obliquely outward at an le to the resting plane. In *Culex* the body is held parallel ne of the resting surface, and the head does not point to it. rising how quickly this character will be appreciated when en once seen, and even at a distance the difference is quite A reference to figure 25 will make this point clear.

Life History.

y investigators have been at work during the recently past t the life cycle of *Anopheles* is fairly well known, and the unt here given is partly a com- upplemented by personal ob- made by me or by my cor- ts. The matters of breeding read of the insects in the l places for hibernation are treated.

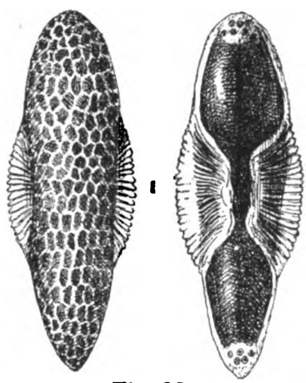


Fig. 28.

Egg of *Anopheles maculipennis*, from below at left, from above at right, greatly enlarged. (From Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

cies of *Anopheles* make no egg- l do not in any way fasten the l eggs together. They are laid he sides and loosely grouped, so float in little masses on the sur- ng the vegetation in which laid. From 50 to 75 seems average for such a mass, ere may be either more or etimes, indeed, a larger mass into fragments and small five or six, or even a less number are formed. The eggs are n shape, the ends pointed, though not quite alike, and at first olor is black. Seen under the microscope, they are rather arked and sculptured, the upper side being almost cov-

e above was written Mr. Kotinsky informs me that he has taken it at ape May county, and Dr. H G. Dyar that he has it from Billport, Long

ered by a clasping membrane, which comes over
Figure 28 will give a good idea of the egg of *A.*
it need only be added that the actual length is
hundredths of an inch.

The eggs hatch in about forty-eight hours, and the
first become readily recognizable, are black or blacki
white or whitish spots and bands—"speckled-bac
respondent terms them. They vary greatly, and n

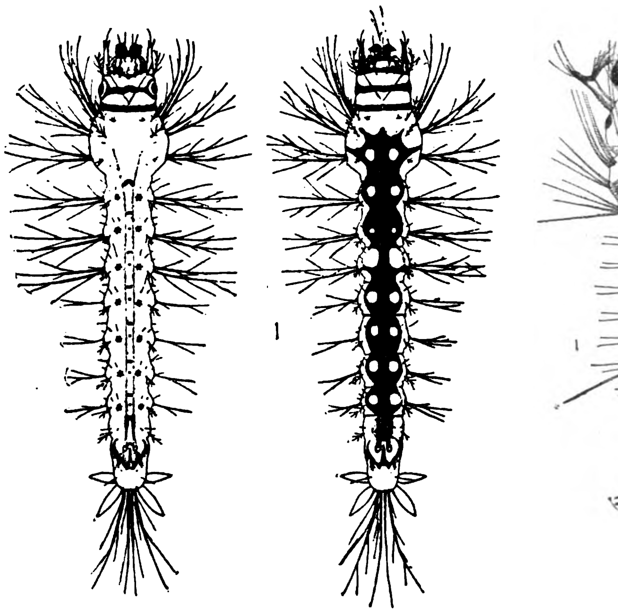


Fig. 29.

Half-grown larva of *Anopheles maculipennis* at left and center, same s
at right, for comparison; much enlarged. (From Howa
25, n. s., U. S. Dept. Agl., Div. Ent.)

entirely alike. At this stage they float anywhere
the water, usually with the head toward the center
pool, and feed on whatever comes in their way. M
been with *punctipennis* chiefly, and this will attack a
if any shows an inability to hold its own. Unlike t
that of *Anopheles* floats on the surface of the water
beneath it unless seriously disturbed. There is a
breathing tube, and, altogether, the larva is quite di
ance from its ally. Its habit of surface feeding en

water, at the edges of pools and among masses of floating
›n—even over floating or partially submerged leaves, where it
om most aquatic enemies. As the larva increases in size it
loses its speckled appearance and becomes more uniform,
from gray to black in one direction and to bright green in the
Mr. Seal considers this a protective character, and shows
e that there is a direct relation between the color of the larva

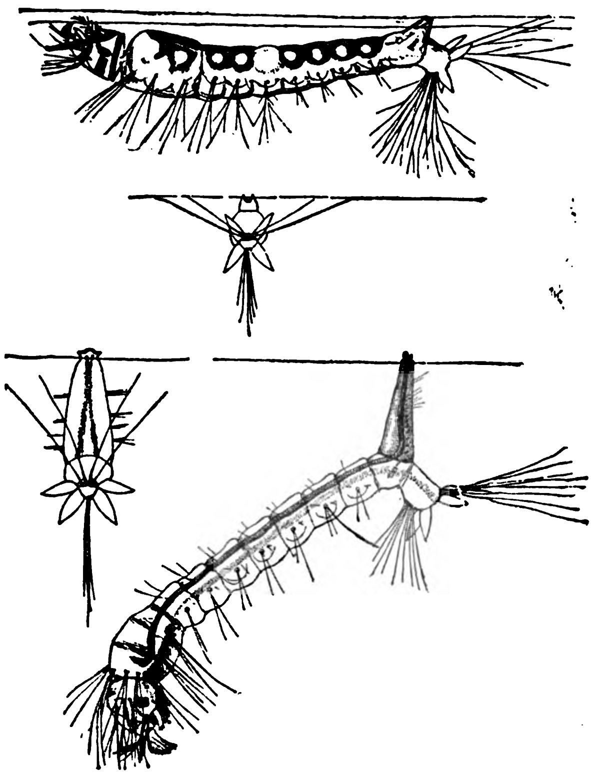


Fig. 30.
Larva of *Anopheles* (upper) and *Culex* (lower), showing comparative positions at surface of water; enlarged. (From Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

ıabitation. It should be added that the head of this larva is
ly movable and can be completely rotated; in fact, the larva
ather a practice of feeding with the bottom of its head at the
of the water, while it floats otherwise naturally, back up.
arvæ of the two more common species resemble each other
n general appearance and habits, but there is a difference in

the markings of the head, which is usually recognizabl
there is no need for distinguishing them.

The larval life varies in length, according to th
Howard mentions sixteen days in May, but this is mu
is required later in the season. From seven to ten d
height of the breeding season, is perhaps the minimu

When full grown the larva changes to a pupa, whic
bles that of Culex, but there is a little difference in
the breathing tubes on the back are shorter, with
flaring opening.

The pupal period is given as from five to ten days b
This was in June, at Washington, and five days is
time given. These observations applied to *maculipen*

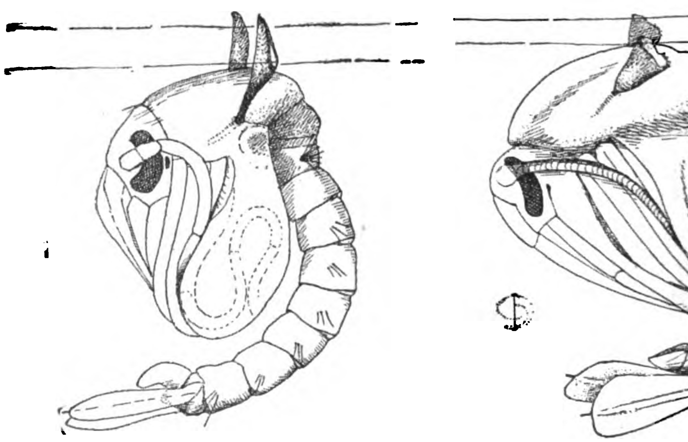


Fig. 31.
Pupa of *Culex pungens* (at left) and *Anopheles maculipennis* (at right), much enl
Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.

long for *punctipennis*, in New Jersey. At Bordentown
reared a series of specimens June 17th, all of which
days only. June 19th, another lot emerged in sever
not much over two days in any case. June 28th, of
collected, one pupated and produced an adult that
period of less than eighteen hours. July 1st, five pu
A. M., and from these two male adults issued at 2 P. M
five hours. This is the minimum period observed, b
numbers bred by me in the laboratory, few remained a
eight hours in the pupal stage. It is almost certain
mosquitoes the occurrence of any adverse conditions ha

l I am quite sure that the whole life cycle of this species npressed into a period of ten days, or even less, in case of

facts concerning the habits and modes of life will appear ly under other headings.

le number of broods occurring during the season, it is im-o speak definitely. Development is so irregular that in t breeding places all stages can be found at any time during er, and broods, strictly speaking, do not occur. When a ready she oviposits, whether her sisters of the same brood dition to do so or not, and so we have a continuous develop-dults throughout the summer and lasting far into the fall.

Where Does Anopheles Breed?

n be answered in one word—everywhere! I have had he breeding-pails in my back yard and have found no pool icant nor stream too rapid but that somewhere in it *Anophe-*ed. Nor is it confined to any one part of the State. Swarms re in the waters of the "Pines," in Ocean, Atlantic and counties and near the top of Mt. Olive, in Morris county, above the sea level. And it need not even be fresh water, ckerson, in his collections on the Elizabethport meadows, arva of *A. punctipennis* in decidedly brackish water, in which l to maturity in the laboratory. For its range of breeding *opheles punctipennis* is thus unequaled by any other mos-he State; but I have never found it in cesspools, nor in springs. It does occur, however, in streams taking sewage, water is really filthy and grease-covered. Ordinarily, the ot occur in large numbers at any one point; but even that is sally true. Mr. Dickerson reports on a puddle, three feet by long the roadside, toward Budd's lake: "The water may of some days' standing, as there had been several showers t few days; but that it was rain water was evident from its nd the situation of the puddle. I was surprised to find *Ano-*uch a situation on top of the mountain, in a mud puddle, urprised at the number—more than I had previously found place." The wind had driven them toward one end of the there they simply covered the surface. A number were proved to be *A. maculipennis*. During the months of June, August Mr. Brakeley made a systematic investigation of

all the creeks near Bordentown and found *Anopheles* them, from the little spring at the head to tidewater. sion when I was with him larvæ were taken from t there was hardly enough water left to dip up. Yet a at the edge and under the shelter of a fence rail lar So it was in every puddle to the point where the enough for a continuous flow. Then frogs, tadp things came in and mosquito larvæ sought shelter an or in a quiet bay. Living as they do on the surface, t with very shallow water, and, resembling somewhat th masses of *debris* always found among the vegetati escape notice. Three creeks were thoroughly colle though they differed in character of bottom and ban of flow, *Anopheles* was found everywhere, if nowhe numbers. But it was not in streams, creeks and "ba alone that larvæ were found—in little runs at the foo embankment and in the more or less connected p monly occurring there, they also lived. This is a p fied in many other places, and almost invariably were found. Good railroad building provides for a roadbed, and there are many places along lines whe or less water at all times. These make excellent when none else are around.

Near Bordentown are clay-pits and some brick done there. There are also some abandoned pits wh done at this time and where water has accumulated, These also were collected over by Mr. Brakeley an larvæ of both *Culex* and *Anopheles*—of the latter, inc both species, *maculipennis* and *punctipennis*. Here, a of the creeks, there were sufficient natural enemies toads, frogs, tadpoles and predatory insects, like d their larvæ, to keep down the crop to limited numb may be said generally that mosquitoes develop abu such places as have not been stocked with their natura this is an important point in the practical side of the

On the point of "how long do they breed?" observations are also interesting. Killing frosts for which the thermometer went well below freezing, c end of September, and toward the end of October the of appreciable thickness during the night. Yet this interfere with the development of the larvæ, thoug

ere rarely seen. Mr. Brakeley bred specimens in November ond that had been more than once covered with ice one-eighth k!

illiam P. Seal, of Delair, N. J., was also good enough to aterial for me, and sent in a large series of specimens during n. His collecting was quite different from that done by eley, and on two occasions I was with him through the between Palmyra and his establishment in the woods east . Here the Aquarium Supply Company has a series of ks and large tubs, which form excellent breeding grounds uito larvæ. The country round about is also well adapted oping these pests, and Mr. Seal, in his collecting experience, opportunity to observe their haunts and habits closely.

ding one lot of larvæ, Mr. Seal calls attention to the varia- color; one kind varies from green to black and is over beds *ba.* "Such of them as are green we find over *Cabomba* or en plants in our tubs, and the darker ones in the fringe of nd dark-green confervæ attached at sides of tubs. The forms are all over the surface." These were also found in ponds where there were no fish. "A very few fish will nall pond clear, though no doubt beetle and other larvæ do are." After a further discussion of their peculiarities he would suggest that the horizontal position of *Anopheles* uld indicate the habit of living over masses of plants which he surface of the water. From my limited observation of ould say that is the rational teleological assumption." How larvæ have adapted themselves Mr. Seal shows later, as fol- 'I find we have been unsuspiciously fostering *Anopheles* in nds where we have fish. They are hidden so completely fish, and are so difficult to observe among plants at the sur- t they easily escape detection without very close scrutiny. bor also in grass on the edges of streams, and are never like *Culex.*

agine that the ornamental ponds in parks and gardens are ources of *Anopheles* supply. In one plant-pond we have ws (*Gambusia*). In that pond there are no mosquitoes of ."

al's sendings continued until November 5th, on which date from half-grown larvæ to pupæ were received.

occasions when I went over the collecting grounds with one place attracted attention as illustrating the manner in

which mosquito breeding grounds are created. A tid
the Delaware flows through a marshy or swampy distr
bridged road and by a railroad embankment in such a
a section of the swamp from tide-water connection. O
embankment fish occur and mosquito larvæ are almos
ing; on the other every dip of the net brought out
Culex. An area of several acres has been turned i
breeding ground by failing to provide the railroad dam
ing through which the tide might ebb and flow.

The Spread of Anopheles.

It has been stated that *Anopheles* does not fly far,
ment has been repeated again and again. But "far
term. It may not cover so much territory as *sollici*
mens have certainly been found, in some numbers fr
to one-half mile away from any place where they
breed. This seems like a positive assertion in view
so little is required for a breeding place; but Mr.
every foot of the territory where these insects were fo
my authority in this instance. So I have myself fou
circumstances that indicated an even longer flight,
range, there is scarcely a city and certainly not a to
that cannot be easily overrun by *Anopheles* from su
places in its vicinity or even within the town or cit
breeding places, natural or artificial, occur throughou

Anopheles is a house mosquito, *i. e.*, one that re
shelter, is attracted by light, and will remain in buildi
of choice. In the evening they come to porches and
through screens. Specimens have been observed wo
through the wire mesh, and in my own bedroom I h
Anopheles than *Culex* during the late summer of 1901.
of them during the day, and they are not easily starte
hiding places. But I have been bitten very early i
laboratory store-room, where, evidently, a small col
hibernating quarters.

How Does Anopheles Hibernate?

That the species of *Anopheles* hibernate in the adult s
by those who have studied the subject, and this is un
as a very pretty series of observations made by Mr. B

g the late winter of 1900–1901, Mr. Brakeley found in the oom of his cranberry-house occasional specimens of *Anopheles*, concluded came in with the cranberry crates brought from house. When they were brought into the warm room they active, flew toward the windows, and on rare occasions a evinced an inclination to bite. There were no large num- ny time, but a few were brought in with almost every lot of d these were regularly caught off, so there was no such thing ble count of the same example. A few specimens were also the dwelling-house, and, altogether, during the season, quite one hundred specimens were taken in and about the d cranberry sorting-room. All were females.

ring set in fairly these specimens disappeared. They were out of winter quarters and ready for outdoor life. They followed, but in May Mr. Brakeley and myself hunted what we considered likely places, finding none. As the dvanced larvæ were found in abundance at other places, and ention was paid to Lahaway mosquitoes because of Mr. 's absence in Bordentown. In September observations at were resumed, and larvæ were found in small numbers in a ing pool connected with a larger pond. After the middle of h specimens began to make occasional appearances at night, a number had been taken by the beginning of October.

g in mind the fact that so many specimens had been found e winter in the Cranberry House, Mr. Brakeley made rather atic search in the storage building, and found in and about ty crates several hundred specimens during the collecting Most of these were in the crates, which were laid flat side down, mainly suspended from the upper side. Specimens were d in other parts of the house, and evidently in a state of or. There had been a series of cold nights, in which the went well below the freezing point, and the house was dusky even in midday.

the 20th of October several tubs, which had been placed ide up in the storeroom of the house, were turned right side n each a number of *Anopheles* were noted and taken. Then under the house came in for an examination, and in three rly 1,500 examples were taken. The foundations of the of masonary, forming the walls of the cellar, which is di- o three parts. It is feebly lighted at one end by small win- at the other end from the doorway. The mosquitoes were

everywhere, but least abundant in the further cellar
ful near the door, as if they had come in that way.
of doors, in almost absolute darkness, they buzzed abou
of bees, when disturbed. Collecting was done with a
the ceiling, rafters, supporting posts and side walls
most plentiful on the ceiling and rafters.

Over 1,000 specimens were sent to me, and all
Most of them were very bright, perfect specimens,
flown, and most of them were very plump. On dissec
men was found to be full of fatty tissue, with no food
tary canal and undeveloped ovaries. Pickers' cabi
wagon-house and cellar of tenant-house were also exa
all cases the record was the same—*Anopheles* by the hu
well within bounds to put the number actually obse
buildings at over 5,000, and nearly 3,000 of these we
Just when they resort to hibernating quarters is yet
but it is probably not much either side of October
grown larvæ and pupæ were yet found after Novem
stant additions to the hibernating colony were made
least.

No doubt *Anopheles* hibernates in the adult stage,
only, whenever it can find shelter in buildings. With
population of over 2,000 in the house, and as man
about, in other buildings, malaria should be a pre
here, but it is not; in fact, the only cases ever known
brought in to get well!

But where do they hibernate where there are no
cellars? Mr. Brakeley answered that question as w
them wherever there is an overhanging turf or sodba
mint" hole in a sloping bank or gully. An area ab
long and two miles wide was thoroughly surveyed, and
every overhanging turf bank *Anopheles* was found,
suspended from the rootlets. In burrows of small ani
on a sloping bank, many were seen or taken, a puff or
causing them to fly out and be captured. All these
sent in to me, and all are females. This point is impo
of specimens bred at about the same time, as many
females. The males perform their functions in life at
impregnated females resort to hibernating quarters, lea
to die.

This hibernating habit has another important bearing

nancy does not become complete, and individuals are lia-
tten at any time during the winter. This explains some
aria developing at that season, and usually cited to show
no connection between the insect and the disease.
eley, in his notes, from which I hope to give interesting
a future report, speaks of what he calls a "hibernation

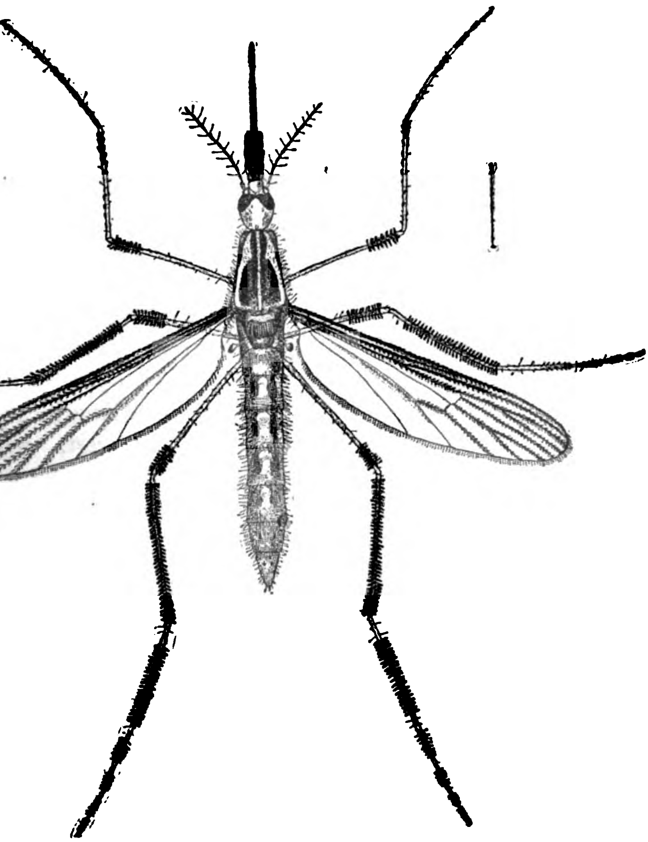


Fig. 32.
ra ciliata, female, enlarged. (From Howard, Bull. 25, n. s., U. S. Dept. Agl., Div. Ent.)

is a method of resting that resembles, yet differs from,
as the normal resting position of the insect. It seems
gs were all more closely folded, and the entire insect
e surface upon which it is resting than at earlier periods
on. It is really a preparation for a long, undisturbed

rest, which, under normal conditions, would last ur spring. It is perhaps doubtful if *Anopheles* leaves it until well along in May, and it comes out then in gr numbers.

OTHER MOSQUITOES.

Though the species of *Culex* and *Anopheles* are th need practical attention, they do not constitute our populati represen other ger *Conchyli*

Of *Ps* one spe *ciliata*, through and is r of our body is f in lengtl at rest, spread area of legs are and the erect bla the insec nizable bite is ir size, an Johnson a coat i It gets t and two apparen draws l Yet the

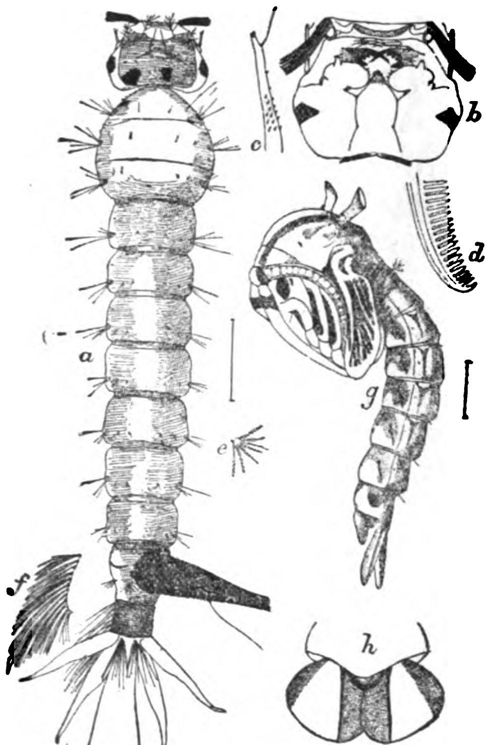


Fig. 33.
Psorophora ciliata, larva, pupa and structural details, all very much enlarged. (From Howard, "Mosquitoes." Copyright, McClure, Phillips & Co., by permission.)

poisonous as that of *Culex* or *Anopheles*, and certain too rare to be of much practical importance. B woodlands for its habitation and horses for food, a

the human beings in their company. On this point thority.

are immense for wrigglers, and are at once recognizable Unlike those of the other genera, they are predaceous, s scarce, also cannibalistic. If half a dozen are placed breeding jar only one will remain at the end of forty- I have tried that with specimens taken by Mr. Dick- east bank of the Raritan river, opposite New Brunswick. men placed in a jar with *Culex* will devour every one According to Dr. Howard's observations the small s simply swallowed entire—the larger larvæ are seized anal siphon or breathing tube, to choke them, and when cease are devoured to the head. The larvæ are therefore compared with those of other mosquitoes. Mr. Seal bout 1 to 1,000 of *Culex*, where they occur together.

s sent me from time to time, during the season, specimens , according to his observations, they always come in filled by rains, after a previous drought has killed off and other predatory insect larvæ. It is obvious that ggler as a *Psorophora* larva would fall a ready victim to ns.

le is very short and the development exceedingly rapid. es: "On one occasion it began to rain on Monday water soon collected in the bed of a dried-up pond. t place there was a patch of damp mud with a rotten it. On Tuesday there were thousands of *Culex* larvæ hth of an inch long, and a few *Psorophora* about a inch long. Pupæ of both forms had developed by on Monday all had emerged. The development after nty-four hours appears to be proportionally slower, to the suggestion of a possibility of oviposition and ment in the egg before the rain began."

suggestion is that, while the larvæ undoubtedly need r development, the eggs are not necessarily dependent e sudden appearance of larvæ after a rainfall sug- ossibility that mosquitoes may be weather-wise and s may be deposited in the mud, in damp, dark places, s always sure to collect, as for instance, under logs, ., some time before rain actually falls. As the eggs ito simply float on the surface, there is no reason why ot develop while resting on a bed of mud, from which

they could absorb whatever moisture they mig
were a necessity."

Some information communicated to me by Dr.
ing *Stegomyia fasciata*, the "yellow-fever" mosqui
vations made by Mr. Brakeley on the egg-laying h
additional support to Mr. Seal's belief, as does an
own. On one occasion I reached a seaside hotel
a heavy rain, which precluded collecting that day
a preceding dry period, and the downpour contin
tions during the night. Next day it continued
sional showers, but I tramped the meadows in gun
10 o'clock. I found in a grassy area about one in
a mere matter of curiosity dipped up a small gla
prise it proved to be swarming with recently-hatc
none more than an eighth of an inch long, and the
an acre or more. The meadow was only a little low
ing roads, and nowhere was there more than a thi
I was assured that there had been no water befor
day previously, and informed that a filling up
with every heavy shower and lasted several da
ing to the succeeding weather. After three days
lessened materially because it continued cloudy,
then more than half grown. It seems probable
already in the meadow before the rain began and
as soon as there was sufficient water for their sup

Of *Conychyliastes* we also have one species, *C.*
rather a pretty insect—black in general effect,
markings, and the last two joints of the hind tars
have an iridescent appearance, and, altogether, it
at once as different from *Culex*. Only three speci
Mr. Dickerson at South Orange, and we know
stages.

Of *Aëdes* we have three species, which differ g
received separate generic designations. I hold th
for convenience here and because they are all sma
rarely, if ever, bite, and are of no economic imp

A. fuscus is an obscure, brown species, very ra
which a single specimen has been bred by Mr. B

A. sapphirhinus is a beautiful little creature wit
on the thorax. Mr. Brakeley has taken this a

mple, but has not bred it. It has been bred by others, but d no larvæ for study.

ii is a small black form, which, curiously enough, is con- ew Jersey to breeding in Pitcher plant leaves. Mr. Brake- ade out the complete life history of this species, and he is o do this for any representative of this series. It is the of which we know that winters in the larval stage, and nds repeated freezings and thawings without harm.

s are laid singly, in newly-opening leaves of Pitcher plants, re there is water in them, and the larvæ develop in the t accumulates when the leaf is fully opened. Interest- e life history is from the biological standpoint, it can be ly referred to here. It proves, however, that the insects, they have the choice, do not always seek water in which the eggs, but recognize a suitable locality for the future nt of the larva. It proves also that freezing temperatures fficient to destroy life in so highly organized a form as a larva, even when it involves absolute exclusion from air for able period. Another marked peculiarity is that the larva pendent upon outer or atmospheric air even in summer. that in laboratory cultures, and Dr. Howard subjected a lot hat I sent him to the test of covering the surface of the jar with oil. They lived unharmed for thirteen days in vered water, which should have killed instantly any exam- pting to get at the outer air to breathe in the ordinary

the species already enumerated, which represents all the ms, there is a genus *Corethra*, in which the proboscis is not and which is not of economic importance. Of this genus s has been bred by Mr. Brakely and myself, from Lahaway, ved heretofore undescribed and which has been named *rakeleyi*, in recognition of the valuable work done in the f increasing our knowledge of these interesting creatures.

REMEDIAL MEASURES.

trike the observant reader that I have omitted references to resting points in the mosquito economy, such as their song, al food aside from blood, and the like. This is not because ppreciate their importance nor because I have no informa- rning those matters. They simply have no direct bearing

upon the practical question of how the mosquito r
almost completely abolished. It will appear obv
have followed carefully my discussion of the sp
calculated to reach *Culex pungens* and *sollicitans*
reach most *Anopheles* and all the other species of *C*
to be troublesome.

In the discussion concerning *sollicitans* it appea
matter of dealing with the mosquito pest is not
cases. For instance, nothing that could possibly

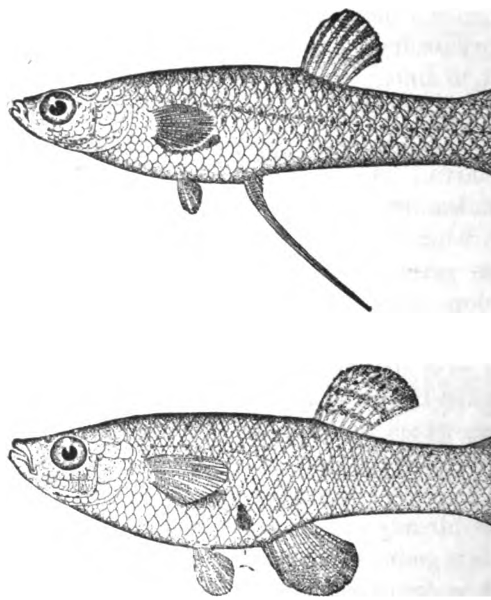


Fig. 34.
Top minnow, *Gambusia affinis*, a little enlarged; male
below. (After Jordan & Everman; from Howard,
toes." Copyright, McClure, Phillips & Co., by permi

would relieve them from the invasion by the s
though they destroy absolutely all possible breedin
town limits. Yet local work is absolutely necess
cases and will repay well all expenditures made.
should be intelligently done, else much of it wil
treatment of running streams or of bodies of wa
frogs or other aquatic animals live, or can be mad
esssary, and even some cases absurd—particul

d is destructive to fish, for then the natural checks are d and any lapse or defect in the artificial treatments will greater trouble than ever. The rational method is to assist ral checks so far as may be and employ destructive agents en permanent works fail to give relief. For instance, it will r to fill a depression in which rain water habitually accumu-h a load of sand than to treat it with oil every two weeks ne summer and every year in succession. And it will pay stock a pond with proper fish and trim its banks, to do h places inaccessible to them, than to spray it periodically or the like.

rst essential in my plan of control, therefore, is to ascertain atural checks and the methods by which they may be made ective. This will require a careful bilogical survey of the habitants of the State, that I may be able to make definite ndations as to just when matters may be left to nature and tive work must be undertaken. It is this survey that a large part of the money appropriation elsewhere men-nd it will involve the study of the habits of certain fishes s of the mosquito larvæ. We are not entirely without in-n on this point, as the following from Mr. Seal will demon-

ng the fishes common to New Jersey there appears to be t can be depended on to become by a general distribution s of *Anopheles* larvæ. The sunfishes, comprising many large and small, are undoubtedly, in the waters in which und, great destroyers of *Culex* larvæ; but it is doubtful they are of much value in the case of *Anopheles*, as they are eeders. Further south—though probably a summer visitor ast of New Jersey—there is a small species which, feeding rface of the water, is sure to capture such larvæ as must the top for air. This is the little viviparous top-minnow *ia affinis*), one of the smallest of our fishes, the largest of them ly about $1\frac{3}{4}$ inches long and quite slender. Skimming the f the water in schools, nothing escapes them. During the nmer two small artificial ponds, stocked with plants, were d by *Gambusia*, and in them mosquito larvæ of any kind n sought for in vain. In other ponds, inhabited by gold-n *Culex* and *Anopheles* could always be found.

H. M. Smith, in charge of the division of scientific inquiry S. Fish Commission, states that he has opened large num-

bers of *Gambusia* and found their stomachs filled
mosquito larvæ.

"Where these fishes occur they exist in great
may be found in water so shallow it will just cove
will follow a water-course to its source if there is
allow them to swim.

"Dr. L. O. Howard, in 'Mosquitoes,' quotes D
Orleans, concerning the value of *Gambusia* as destr
and other larvæ. The writer confirms this value fro
of several winters' observations about Southern cit
experiments at home.

"In dealing with *Anopheles*, account must be ta
mental ponds in our parks and private estates, the

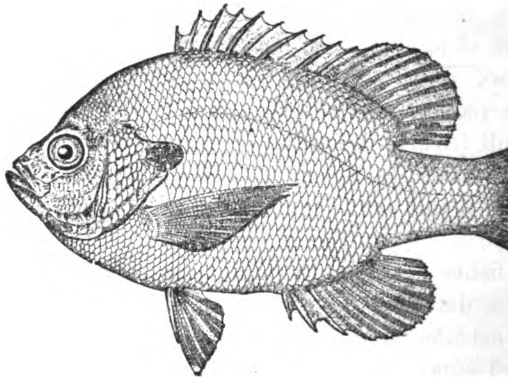


Fig. 35.

Common sunfish, less than natural size. (After Jordan &
from Howard, "Mosquitoes." Copyright, McClu
Phillips & Co., by permission.)

semi-aquatic foliage of which becomes a prolific sou
this genus.

"Water hyacinths, reeds, rushes and other aqua
them from fishes in general, and somehow they se
predaceous insects as the other kinds do not, for, n
are fishes of the most voracious character and swar
beetles and their larvæ, *Anopheles* can always be f
small numbers.

"It therefore seems probable that any attempt to
bers of *Anopheles* should contemplate the general
Gambusia affinis, and as it is a work which, to be e

it should be considered whether our Fish Commissions
ot be media for their collection and distribution.

ng the summer months *Gambusia* may be found in great
in the salt marshes of the coast and in the ditches and
ponds adjacent to tidal streams as far up as brackish water
The extreme northern limit for them is probably the
f New York. In the fall the aquarium dealers there have
arge numbers, probably bought of boys who catch and sell

question of whether *Gambusia* would stand our northern
ould have to be determined by experiment. It has been
ated that some water plants not to be found north of North
will not only withstand the northern winters, but will
drive out other forms that are indigenous, showing that
ent is probably in nature more often a matter of choice
ssity.

usia is rarely found out of brackish water, but it lives and
s as readily in absolutely fresh water, as has been demon-
the rearing of four or five generations of them in fresh water,
nd small ponds."

l's communication deals chiefly with *Gambusia* as an effect-
in controlling *Anopheles*, and as this is the form in which
uthorities are most interested, it is well to know that by
p channels by means of which this little fish can get into all
ich marsh areas as the Elizabethport and Newark meadows,
ortance as breeders of disease-spreading mosquitoes can be
reduced.

noted on a previous page that wherever the tide ebbed and
en if at ebb only puddles were left, the swarms of little fish
se pools effectively prevented mosquito breeding. As against
æ, sunfish are quite effective in any bodies of water not too
rgrown and not too shallow at the edges, and these flourish
e State. I have verified this again and again in ponds and
habited by them about cranberry bogs, which would other-
been excellent breeding places for mosquito larvæ.

re. running streams and permanent ponds or water bodies
t be treated with oils or other material destructive to fish or
atic life. Let us rather foster the fish or even the frogs and
clearing up permanently the places inaccessible to them.
will this be in the long run the cheapest method, but it is

also much the most effective. On this point Mr. Se personal experience, writes as follows :

"By reason of their adaptation to an environment protection, the various species of *Anopheles* enjoy a g from destruction by fishes, tadpoles, aquatic insects and from the coal oil treatment, than do those that

"*Anopheles* is the first to appear after coal oil ha and if the oil is not carefully worked by agitation ar and weeds bordering the shallow edges of ponds, and tracks holding water around the margins, the cha great many mosquito larvæ will escape destruction."

The center of a pond or stream of any size affo place for mosquito larvæ. They do not, or perha in the ripple area.

It is probable that more thorough investigation wi natural checks of which we may take advantage.

A second part of my scheme for controlling the New Jersey is the destruction of their natural breedi as is possible, and this involves the study of th for such destruction under varying conditions. So enough : the filling-in of sunken lots containing st cities and towns, especially in the outskirts, and th ing of city drains and gutters. These are local affa left to the boards of health or other authorities, b information for intelligent action should be placed succinct form. Drainage of marsh and swamp area immense extent of salt marsh previously described, i and, if we are to do away with the most troublesom some treatment of the latter is imperative.

At first sight this problem seems beyond our po expenditure of immense sums of money ; but wh study it more closely it becomes less formidable, a many interests, not only willing, but anxious to assist that not only owners of shore property, but commu inland, are involved, and that it is a State, rath matter, though the local authorities must assist. As t in shore resorts are of immense value and will be times if the mosquito pest be controlled, no difficult experienced in securing their co-operation. Many o have already expended considerable sums in this generally good results. Thus, at Seaside Park every

citans has been abolished by grading and filling, so that in a y search I found not a single larva.

tment of two kinds is indicated: First, providing free access inary tides to all parts of the marshes, and drainage from areas only at ordinary storm or spring tides. It is not necessary to he areas in the sense of leaving them permanently dry, though ll be the ultimate result when they are made habitable. It is ecessary, at first, to do away with those stagnant areas whose tion with the sea is intermittent. The simplest kind of ditch- often all that is necessary; but it needs an investigation to here those ditches should be and what areas are of greatest ance. Second, filling in or grading, in those areas where only storm tides leave pools, which last until June or July and in the early supply is produced in countless numbers. No s of mosquito larvæ occur in such pools, and breeding is ab- unrestrained for weeks. At Anglesea I found one such area e, which had become so reduced that a single load of sand have filled it, but in which several thousand larvæ and pupæ varming and from which had emerged many times that num- dults then resting on the grasses around about. A few days' or one man with a shovel and wheelbarrow would have abol- hat whole area, material for the filling being immediately at n the form of sand-hills. This sort of work is within the e of the communities where such areas exist, and owners of could, at the expense of only a few hundred dollars, do away l breeding places of this character in a considerable territory. been already stated that at Seaside Park such work has been fully accomplished and the local supply has been completely ted.

mportance of a material lessening of the mosquito pest to the Jersey City, Newark, Elizabeth and to the surrounding towns rdly be over-estimated, and such a study as is contemplated would indicate just what measures should be taken to obtain irable result.

e remains a class of cases which must be dealt with by local netimes individual action. That is where the insects breed barrels, cisterns, temporary pools, cesspools, liquid manure aggish ditches and the like. These are not always amenable ral treatments, and in such cases destructive agents must be ed.

implest of these is petroleum, which may be either the crude

product, the refined kerosene, or a fuel oil, which i
either and equally or even more effective. Sprayed
of a pool, it forms a continuous film, which is fat
attempting to lay eggs and to the larva coming to the su
It remains effective as long as the surface film is unb
all exposed to the wind is apt to be driven to one s
eventually to the shore, into the ground. It requi
newals, therefore, and, as Mr. Seal has already show
carefully used if satisfactory results are to be obtaine
or sheltered places it will afford protection for a long
barrels it will not interfere with the water if drawn f
will not, ordinarily, result in the death of fish if an
pools. It requires about one ounce for fifteen squa
surface.

Another material which has been used during the
South Orange is "Phinotas Oil," a mixture pr
Phinotas Chemical Company, of New York City. I
cents per gallon, with special discounts, and is appli
of a coarse spray. Its composition is unknown to m
from its effect and its odor, seems to contain carbolic
on the surface, it sinks to the bottom in large globul
a whitish material, that rapidly turns the water mil
moments the globules rise again to the surface, burst
oily film in every direction. This milky solution is
mosquito larvæ and to aquatic life generally, inclu
laboratory experiments I found that even a small pe
milky water, added to a jar of mosquito larvæ, killed
few minutes, while any large amounts killed almos
This active effectiveness remained for two weeks and
longer, but my tests were not carried beyond that poi
be no question, then, as to the killing qualities of thi
for use in cesspools, stagnant water areas, manure p
breeding places generally, there is nothing better or
cannot be employed in rain barrels or cisterns, where
be used for domestic purposes. Nor is it advisable w
fish, for if these be destroyed with the predatory ins
dependence upon artificial checks becomes absolute, a
to make timely applications will result in mosquito
than ever.

Of course, the question whether all this is really p
be asked at once. I have no doubts in the matter r

is borne out by those who have studied the subject. Dr. L. O. Howard, from whose work on mosquitoes most lustrations here used have been obtained, is quite emphatic point, and quotes approvingly a statement that there seems no more reason for enduring the mosquito scourge than in smallpox to ravage communities, as it used to do before the Jenner."

ong Island an area embracing 70 square miles has been under t during the summer of 1901. A large area of marsh land claimed" in the vicinity of Boston in 1900. In Connecticut, informed, a considerable territory along Long Island Sound n made habitable by destroying mosquito breeding places. k done at and near Havana by the Marine Hospital Service n remarkably efficient, and good results seem to have been on Staten Island by Dr. Doty.

empt has been heretofore made to clear a State of these pests, any local attempts are now under way that it becomes im- to show just what can and what cannot be done by such

ot wish to be understood as attempting the *destruction* of the oes in the State of New Jersey with an appropriation of or any other sum.

to be understood as claiming that with such an appropria- ill be possible for me to make such a study of the subject as ble me to present a consistent plan of action, which will show t can be done by the individual, the local community and —a plan which will attain the result slowly or rapidly, in on to the energy or listlessness with which it is carried out, ch will prevent discouragements and failures due to attempts plish the impossible. All this I believe may be done, and I no reason why, inside a decade, New Jersey mosquitoes ot be reduced to such a point as to be practically unnoticed. nation, be it noted, is *not* claimed. The plan contemplates nt relief, based upon intelligent activity, along well-defined

TWENTY-THIRD ANNUAL REPORT

OF THE

NEW JERSEY STATE

cultural Experiment Station

AND THE

FIFTEENTH ANNUAL REPORT

OF THE

ersey Agricultural College Experiment Station

FOR THE YEAR ENDING

October 31st, 1902.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING CO., PRINTERS.
1903.

TABLE OF CONTENTS.

B

TABLE OF CONTENTS.

Excellency Franklin Murphy, Governor of the State of New ey:

have the honor to submit herewith the Twenty-third An- ort of the New Jersey State Agricultural Experiment Sta- required by the law establishing the Station, which was March 10th, 1880, and which is chapter CVI. of the laws ear.

DAVID D. DENISE,
President.

BRUNSWICK, N. J., November 29th, 1902.

Excellency Franklin Murphy, Governor of the State of New ey:

n compliance with an act of Congress, approved March 2d, d with an act of the Legislature of this State, approved h, 1888, I beg leave to submit, on behalf of the Trustees of College in New Jersey maintaining Rutgers Scientific School, Jersey State College for the benefit of Agriculture and Arts, the Fifteenth Annual Report of the operations of that nt of the College which has been organized in accordance act of Congress, and is known as "The State Agricultural Experiment Station."

AUSTIN SCOTT,
President.

BRUNSWICK, N. J., November 29th, 1902.

JERSEY AGRICULTURAL EXPERIMENT STATIONS,

NEW BRUNSWICK, N. J.

1. STATE STATION. ESTABLISHED 1880.

BOARD OF MANAGERS.

FRANKLIN MURPHY, . . Trenton, Governor of the State of New Jersey.
PH.D., LL.D., . . New Brunswick, President of the State Agricultural College.
ORHEES, SC.D., . Professor of Agriculture of the State Agricultural College.

GRESSIONAL DISTRICT.

., . . . Haddonfield.
, JR., . Salem.

ONGRESSIONAL DISTRICT.

HAM, . . Shiloh.
L, . . . Masonville.

GRESSIONAL DISTRICT.

, Pres., . . Freehold.
. . . . New Brunswick.

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AM, V. Pres., Pennington.
. . . . . Pattenburg.

GRESSIONAL DISTRICT.

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TT, . . . Hilton.

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TENTH CONGRESSIONAL DISTRICT.

JOHN B. WILLIAMS, . . . New Durham.
PHILIP M. BRETT, . . . Jersey City.

STAFF.

D B. VOORHEES, SC.D., . . Director.
S. UPSON, A.M., ... Chief Clerk; Secretary and Treasurer.
. WHITAKER, ... Stenographer and Typewriter.

HEES, A.M., Chief Chemist.
T, M.SC., Associate Chemist.
LEN, B.SC., Assistant Chemist.
RBERRY, Laboratory Assistant.

JOHN B. SMITH, SC.D., Entomologist.
ALVA T. JORDAN, B.SC., Assistant in Horticulture.
CLARENCE B. LANE, B.SC., Assistant in Dairy Husbandry.
JACOB G. LIPMAN, A.M., Soil Chemist and Bacteriologist.

HARRY W. WILLIAMS, . . . Janitor.

CULTURAL COLLEGE STATION. ESTABLISHED 1888.

BOARD OF CONTROL.

The Board of Trustees of Rutgers College in New Jersey.

ECUTIVE COMMITTEE OF THE BOARD.

PH.D., LL.D., President of Rutgers College, Chairman, . . New Brunswick.
. BOOKSTAVER, LL.D., ... 24 East 64th Street, New York City.
, ... New Brunswick.
. . . . Troy, New York.
UPP., ... New Brunswick.
ERT, JR., ... Helmetta.

STAFF.

ORHEES, SC.D., ... Director.
, PH.D., ... Biologist.
STED SC.D., ... Botanist and Horticulturist.
, SC.D., ... Entomologist.
EY, M.SC., ... Field Assistant.
N, A.M., ... Disbursing Clerk and Librarian.
SKE, ... Stenographer and Typewriter.

THE COLLEGE FARM.

the College give the Stations the use of seven acres of land for experiments in Botany, and the remainder of the farm (90 acres), well stocked and equipped, for irying. The income from the dairy pays for the labor and maintenance of the or dairy experiments.

TREASURER'S REPORT.

Upson, in account with the New Jersey State Agricultural
; Station, November 1st, 1901, to October 31st, 1902.

PROPRIATION FOR SALARIES AND EXPENSES.

RECEIPTS.

Treasurer	$15,000 00

PAYMENTS.

pay of Chemists and Assistants	$10,629 12
the Board of Managers	55 15
	242 27
	172 38
	122 98
	2 00
	192 54
ity and Water	228 78
Expenses	965 31
eding Experiment Expenses	1,013 14
ess and Cartage	76 50
llecting Samples of Fertilizers	327 63
penses	115 69
ings, Repairs and Improvements	727 18
	23 09
oks	91 24
Expenses	15 00
	$15,000 00

ATION FOR CARRYING OUT THE PROVISIONS OF "AN
ONCERNING THE REGULATION OF THE SALE OF
CENTRATED COMMERCIAL FEEDING STUFFS."

RECEIPTS.

Treasurer	$3,000 00

PAYMENTS.

pay of Chemists and Assistants	$2,172 27
	1 05
'ittings, Apparatus and Supplies	671 67
lecting Samples of Feeding Stuffs	155 01
	$3,000 00

APPROPRIATION FOR PRINTING BUL

RECEIPTS.

From State Treasurer..............................

PAYMENTS.

For Printing Bulletins.............................

SPECIAL ALLOWANCE BY THE GOVERNOR F
APPROPRIATION FOR CARRYING OUT THI
"AN ACT TO PROVIDE FOR AN INVESTIGAT
UPON THE MOSQUITO PROBLEM, IN ITS R
SANITARY, AGRICULTURAL AND OTHER IN
STATE."

RECEIPTS.

From State Treasurer..............................

PAYMENTS.

Compensation of Assistants....................
Labor ....
Postage ....
Laboratory and Incidental Supplies...............
Freight and Express................................
Traveling Expenses ....
Reference Books and Papers......................

The Auditing Committee of the Experiment St
the accounts of the Treasurer of said Station, ar
correct.

JOHN E. D
GEORGE E
A

New Brunswick, N. J., January 16th, 1903.

FINANCIAL STATEMENT.

THE TRUSTEES OF RUTGERS COLLEGE

FOR

y JERSEY STATE AGRICULTURAL COLLEGE EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1901–1902.

from the Treasurer of the United States as per appropria- fiscal year ending June 30th, 1902, as per act of Congress d March 2d, 1887		$15,000 00
	$9,580 00	
	953 51	
ons	1,506 93	
and Stationery	268 68	
and Express	82 61	
ght and Water	279 15	
Supplies	56 37	
ants and Sundry Supplies	160 90	
s	156 41	
Stuffs	154 62	
	620 13	
aplements and Machinery	104 00	
e and Fixtures	228 94	
Apparatus	204 22	
k	....	
Expenses	383 66	
nt Expenses	171 20	
and Repairs	88 67	
tal		$15,000 00

ndersigned duly appointed auditors of the corporation, do hereby we have examined the books and accounts of the New Jersey State College Experiment Station for the fiscal year ending June 30th, e have found the same well kept and classified as above, and that for the year from the Treasurer of the United States are shown to 5,000, and the corresponding disbursements $15,000, for all of which ners are on file, and have been by us examined and found correct, no unexpended balance.

rther certify that the expenditures have been solely for the purpose he act of Congress approved March 2d, 1887.

Signed, AUSTIN SCOTT,
EDWARD B. VOORHEES,
Auditors.

REPORT OF THE DIRECTOR.

REPORT OF THE DIRECTOR.

ws, both State and national, which provide for Agricultural
ent Stations, have for their purpose the establishment of
ns which shall serve the public mainly in the following
s:

to protect the farmer in the purchase of commercial fertilizers,
ated feeds, and other materials, whose composition and value
e readily discerned by visual inspection; second, to give the
uch information as science may offer in reference to the pur-
d economical use of these materials; and third, to conduct
entific investigations of soils, crops, animals, insects, plant
etc., as may result in the establishment of new facts and
s, which may not only be of service in the farming and re-
lustries, but also add to the sum of our knowledge. The
the results of the work of Agricultural Experiment Stations
refore be regarded as both direct, or immediately useful to
l class, and indirect, or useful to the entire community,
of the dependence of all classes upon agriculture, the basic
.

the staff of scientific workers of the State Station are more
ly occupied with the work of inspection, the results obtained
ve been of more immediate value to the farming public than
the College Station, whose officers are more largely engaged
scientific investigations. The relative value of the two lines
can, however, hardly be compared on a commercial basis, as
the results of a single, purely scientific investigation may
ly have a broader application in actual practice, and be of
alue than work which is of immediate interest. The results
shed are, however, complimentary, and thus more useful to
al public than if only one of the lines of work were pursued;
demands of those who need immediate help are satisfied,
the same time new facts are secured and new principles
ed, upon which the success and progress of the industry

must depend. That the objects and purposes in the of the institutions have been closely adhered to in t past year, is made abundantly evident in the reports officers herewith submitted.

Analyses of Commercial Fertilizers.

A change in the method of securing samples of ferti by the appointment of an officer of the Station as ins of county inspectors, was adopted, and has given gre it is an improvement over the old method in two direc that the work of inspection is completed earlier in th second, the single inspector making this work his wh to secure more complete representation of the variou the market.

The chemists report this year the analyses of 399 sa plete fertilizers, 26 samples of ground bone and 48 san laneous products, a total of 473 samples, an increase of 25 per cent. in the number of brands examined been no cases of direct adulteration discovered, thou number of brands where wide variations from the shown, due undoubtedly to imperfections or carelessn of manufacture. The cost of manufacture and s slightly from that shown to be the average in previ the average cost of plant-food is but little higher.

There are also reported the analyses of 60 samples tilizing materials, 20 special mixtures and 3 home r number of analyses of standard materials required identical with those reported last year; the decrease of analyses of this sort in the past few years is in the result of the education of the farmer by the matter of how to purchase plant-food, which in its was a prominent line of investigation, and from of direct value has been probably of greater useful other one line of the Station's work. The progressive educated; he knows that in the purchase of fertilizers not upon the name of the manufacturer or his brand kind, the quantity and the quality of the plant-foo that are furnished.

The Station has also, as a result of its studies of th of the various soils and crops chiefly by means of fie

rtilizers, been able to give the farmer information as to the e requirements of the various crops; hence, with positive tion concerning what constitutes fertilizers, and more or less e ideas as to the probable needs of his crops, the farmer has ned his "hit or miss" methods of purchase and use, and has l a more reasonable mode of procedure. He is now guided underlying principles which are involved, and as a result of lution in methods, his purchases are direct from the manu-s, either as raw materials, or mixed according to formulas, his judgment dictates as best suited for his conditions.

samples of miscellaneous products include many substances composition is not definite, and the object of the analyses is rmine their usefulness as soil amendments, or as direct ferti- In many cases wastes are discovered which are valuable and great service in the locality in which they are found.

Analyses of Commercial Feeds.

rrying out the provisions of the law requiring an inspection of rated feeds, the Station has adopted a broad view of it, and ly has included in its work the products which required ion, but has made a chemical study of the two staple feeds, bran and corn meal, in order to determine chiefly the varia- their composition and feeding value.

he carrying out of this work, the analyses of 595 different s were required. These, together with a very complete and l study of the various kinds and classes of feeds, were pub- in Bulletin No. 160. In fact, the bulletin is a complete aph on the subject of commercial concentrated feeding stuffs. ation in this work furnishes farmers, dealers and manufac- with definite information in regard to the composition and value of the different materials on the market. This work, lieved, is of the highest importance, though the continuation etailed a study of it will not be required in future, as that published will be sufficient for some time to come.

he course of the inspection early in the year, a number of s materials were discovered, which, though sold as feeds, are y termed "feed substitutes." The very great importance, the producers of genuine articles and to consumers, of a dge of the character and composition of these materials, was rent that their investigation was rapidly prosecuted, and the

results published at once in Bulletin No. 156. Fortu
feeders of the State, very little evidence was found of t
spurious articles in the making of mixtures, and ve
the distribution of the bulletins, the manufacturer
objectionable of the articles removed this business f
The multiplication of products suitable for feed, due
and improvement in manufacture, makes the consta
of the character here reported of very great service,
standpoint of protection and of education.

The very large amount of work involved in the
analyses of fertilizers and feeds is only possible b
gradual improvement in the methods of analyses, wh
ally shortened the time required for many determi
work is of the highest importance, and the chemist
time to such study.

Chemical Investigations.

In addition to the work of the laboratories as alread
investigations involving the chemical analyses of nur
of experimental crops have been made. The farm c
analyses are those obtained in experiments designate
adaptability and usefulness for our conditions, and
either additions to, or as subtitutes for, crops now re

Plant Nutrition.

Other scientific investigations which required a ch
called for the analyses of 294 samples. These inves
for their object, a study of the relative value of th
different materials, the changes and losses that occur i
of yard manure, the value of the constituents in the m
carefully and when wastefully handled, and the rel
the constituent nitrogen in these manures as compa
forms in artificial materials. Naturally, in investig
sort, positive facts cannot be obtained without subject
in the process of the experiment to a rigid exam
analyses must include the soil, the manure and the
work must continue until such a number of crops
cluded, and seasons covered as to provide for the va
to occur. This work also permits the further stu
losses of nitrogen contained in soils and in manures, du

vorable organisms that may exist in them. The results thus ined are very striking, and show the losses that are liable to the present methods of use of farm manures, though they prove that the losses are entirely due to their careless use. y great and far-reaching importance of a study of these and of the chemical and biological relations of soils, con- e wisdom of the managers in establishing a laboratory for dy of such relations. Its first report is incorporated here- In connection with the careful and required laboratory studies t nutrition, field experiments were also carried out to study tive effect of nitrate of soda as a source of nitrogen, and No. 157, entitled "Field Experiments with Nitrate of Soda ket Garden Crops," was published.

Soil Chemistry and Bacteriology.

investigations included a preliminary examination of the soils of South Jersey, a study of the losses of nitrogen from s inoculated with pure cultures and with mixtures of bac- d the individual peculiarities of the different organisms. In y of the morphology of denitrifying bacteria, four organisms lated, the first one of which is distinct from any hitherto d, and was named Bacillus New Jersey. Another one resem- New Jersey, and yet possessing some marked differences, sed as a variety of it and called B. New Jersey variety. The o are symbiotic, that is, destroy nitrates with the liberation ous nitrogen only when growing together.

tudies in the physiology of denitrification included observa- the conditions of denitrification, particularly as to the organic nds best suited to the denitrifying organisms for the destruc- nitrates. The amounts of nitrate nitrogen transformed ganic combinations, and the amounts set free were deter- and attempts made to determine whether denitrifying bacteria er certain conditions also fix atmospheric nitrogen.

chemical work involved required in all about 200 nitrogen nations and about 125 determinations of volatile matter in t soils and 450 nitrogen determinations of cultures and culture s.

HORTICULTURE.

In this department, the field work is materially
year to year, as the various varieties of fruits com
The season was not favorable for blackberries and
very favorable for tree fruits. Large crops of cher
peaches were obtained, and the influence of the diffe
manuring is becoming more apparent each year; a
varieties of pears and apples also came into bearing f
this year, though differences due to different treatm
observable. The very great advantage of a caref
varieties of asparagus is, however, very marked agai
Palmetto showing a greater resistance to disease, and
yield than any other variety, though the treatment
each case. Experiments on the irrigation of aspar
fruits were continued, and the results prepared f
Experiments in the forcing-houses have been cont
learn what crops are best adapted for commercial pur
the methods of manuring and treatment best adapted
far tomatoes, cucumbers, lettuce, cauliflower and b
shown to be well adapted for the purpose, though
cucumbers are much more profitable than the others.
fertilization adopted has been shown to be superior to
though the method of use of the manure is an import

DAIRY HUSBANDRY.

In this department of the Station work, the study
bility and usefulness of various forage crops, and of
soiling system for the dairy, have been continued.
the results of the experiments with the growth and
various forage crops have been published; Bulletin N
"Soiling Crop Experiments," has created a very ma
the part of farmers in this, as well as in other States,
improvement in the dairy farm practice of the State is
able as a result of the Station's experiments along t
the past few years. The field experiments in the gr
crimson clover and cow peas, and their use as subs
feeds, were continued, and the results published in B
entitled "Alfalfa, Cow Peas and Crimson Clover as
Purchased Feeds. Home-Grown Protein versus Purch

of work has for its object the encouragement of the growth number of legumes, or protein crops, which, if made into d with corn silage, the great carbohydrate crop, will reduce or the purchase of protein feeds. The results of the experiwed, for example, that when milk is worth $1 per hundred, om feeding home-grown rations, rather than those which he purchase of protein, amounted to about $2 per cow per d also that home-grown crops could, with this price for tilized in the dairy at a greater profit than could have been om selling them at the market prices. These points are of est in our dairy sections particularly, and if observed will only in causing larger direct profits from feeding, but in the ent of the soil, and consequently increased crops.

periments conducted to determine the advantages of topf nitrate of soda for the early and summer forage crops, and millet, showed the very great advantage and profit thod of practice.

n and its equipment, which make these experiments posnot, as many believe, belong to the State, but are the f Rutgers College and loaned to the Station for experiurposes. The farm must therefore be self-supporting; products of the dairy are sold. This situation is taken of in order to study, not only the economical production of also the problems connected with its preparation and for the retail trade. The actual data thus obtained are useful in showing the necessary losses and expenses n handling and selling milk, and the relative advantages olesale and retail disposal. A report of the operations of n considerable detail, together with a financial statement, ch year to the Board of Trustees of the College, and it is t the data contained in these reports may be arranged for n.

States the Experiment Farm is owned and the equipment by the State, and the expenses of carrying out the experid entirely from the funds specially appropriated by the s not necessitating close business methods in the sale of n order to meet the expenses. Where the farm is supits income, as here, it would seem that the State might special appropriation for its more complete equipment in it may serve a better purpose as an object-lesson in all ins to modern practice to the farmers of the State, who

now regard it as of great practical service. Visit parts of our own State and from other States; interested in the same things, and a better equip in machinery than the farm can afford from its o add materially to the value of this feature of the S regarded as the one of most direct value to the pra

Where the sole purpose of the farm is for instru the line of experimentation should not be influ considerations, notwithstanding the many advant experiment farm conducted on a business basis, a out.

BIOLOGY.

In this department the work of the Biologist in tions connected with oyster culture, which was b been continued. The principal need of those eng industry is a method of raising seed oysters that certain in its results. In the first report special a to the early development of the oyster egg befo hatching to the swimming fry. In this year's re ceeding stage of development has received attention preceding the fixation of the spat. Therefore, d particular attention was given to the comparison o ent varieties of oysters in regard to their powe Contrary to anticipation, it was found that "Sout duced fry of stronger viability than any other oyst tion was also given to tank culture of the fry, b subject is the ultimate goal of the studies, and attention until after the determination of the effe temperature and salinity of the water on the cont

The report of the Biologist also contains records and autopsies of tuberculous cows, the last of the for eight years under observation and experiment.

BOTANY.

year 1902, the work in the Botanical Department has been vided between experiments upon the trial grounds and in iouse.

me and attention have been given to the breeding of truck plemented with variety testing. Thus the crossing between nderson" and "Burpee" dwarf lima beans has progressed, eginnings of new sorts are in sight that combine important In this work a number of crosses that are climbers have , thus giving rise to pole sorts that may prove of value.

ggplants, the present season has been occupied with the a cross between the "Long Purple" and the "New York ," with the result that this new and somewhat bell-shaped superior to any of a large number of standard sorts that n for comparison.

rk in breeding tomatoes has gone on in both field and e, with additional hope of gaining a combination that will s with but few seeds, and a high quality of flesh.

g for a smooth (spineless) cucumber is in progress. Last cross was secured between the "Telegraph"—a variety e for its length and seedlessness—and a celebrated Aus- (Znaim) that has fruited in the field, and may prove an ı.

ing sweet corn, a pink sort has been nearly established ' Black Mexican" and "Egyptian," though further work ı is still needed to give uniformity to the number of rows and other desirable features of a distinct breed.

de work has been continued, particularly in the green- t has been determined that mildew has an effective remedy e emulsion. It still remains to establish the most economi- l of applying the mixture. A study is being made of the favoring the growth of mildew under glass.

ıents with dodder and other parasitic plants, as broom- ılso in progress.

tions as to the prevalence of asparagus rust have been ugh the season, and by correspondence with other Station ome additional facts as to its habits have been obtained.

No. 151, "Bean Diseases and Their Remedies," was this department during the year.

ENTOMOLOGY.

The principal work of the season was the begin
gation of the mosquito problem, and excellent
already obtained, which promise the ultimate suc
The facts ascertained concerning the salt mar
deemed so important that Special Bulletin "T" v
The other lines of work have not yet advanced fa
final reports possible.

The occurrence of Brood XXII. of the Perio
opportunity to fix its distribution in the State, an
known to occur in New Jersey have now made
during the period which the Entomologist has
summary of their distribution is contained in his r

The results of the work in the experiment orc
and published in Bulletin No. 155. The rose scal
so as to become injurious, the results of the s
ments made were published in Bulletin No. 159.
winter and early spring, the applications of lime
in orchards infested with the San José scale wer
part directed, and the effects of the wash were
throughout the summer. The results of these obs
with those of experiments in other States, were pr
No. 162, issued in October.

Numerous inspections of nurseries and orchar
all sections of the State, and there is no county
visited at some period of the year in an offici
Entomologist.

The usual lines of current work, such as te
investigating local outbreaks, determining the cl
complained of and suggesting remedies, occupie
remained. The collections of the department co
and in their care, Mr. E. L. Dickerson, assistant
mologist, gives material aid. Several cases have
exhibition in the State museum at Trenton.

FARMERS' MEETINGS.

ork of the Station is not limited to scientific investigations cal experiments. It aims as far as possible to carry the f the work to the farmer in the field, and as in the past, officers of the Station have been present at meetings of hroughout the State. Owing to the advances in the thought k of the farmer, this requires more time and work on the he officers than heretofore. The Station also serves as a f information, not only in matters pertaining directly to but in many other matters, only indirectly connected with but of interest to the general public.

EQUIPMENT.

rious departments are well supplied with the needful scien- iances and apparatus. Many new pieces of apparatus are required in order to do advanced work.

brary is well supplied with the important technical works, periodicals and journals, connected with the science of re, and many additions are annually made. Much progress been made during the year in securing complete files of. iterature.

REPORT OF THE CHEMISTS.

REPORT OF THE CHEMISTS.

FERTILIZERS.

ES OF FERTILIZER SUPPLIES, HOME MIXTURES AND SPECIAL COMPOUNDS.
ALYSES AND VALUATIONS OF COMMERCIAL FERTILIZERS AND GROUND BONE.

uction.

ade values of fertilizing ingredients for 1902, and the examina- n of the standard materials supplying them.

camination and valuation of home mixtures and special com- unds.

camination and valuation of manufactured brands and sundry terials.

1.

INTRODUCTION.

following pages is reported the work of the Station relating ers and fertilizing materials during the past year. This been steadily increasing until now it is of greater magni- ever before, and has completely occupied the time allotted this connection, it becomes necessary to state that since n has been charged with the inspection, along the same the feeding stuffs to be found in the State, the demands time of the Station's staff are such as to require concentra- upon systematized work. From April 1st to October 1st, has been allotted to the examination of fertilizers, and from 1st to March 1st to the examination of feeds. In order

to serve the public to the best advantage, the Stat
nounces that it has become obligatory that the exan
fertilizers nor feeding stuffs be undertaken out of th

In connection with the inspection of feeds, Mr.
in 1901 permanently added to the Station's staff,
was assigned the duty of collecting the samples thr
State. Mr. Allen's services being available, the
this year applied to the collection of the fertili
system has been equally successful, and the Statio
severance of its relations with the local inspector
had been doing this work for years, solely becaus
by them as a matter of vital interest to the farmin

The inspection this year has been quite thoroug
twenty-one counties of the State have been visited,
drawn and shipped to the Station. As fast as re
all been recorded under a distinguishing number.
duplicates of each brand a selection for analysis
with the aim that the samples of any one firm shal
portions of the State, and represent their largest st

This method of selection, it is believed, is more
strate the general quality of the fertilizer output,
cause insinuation or distrust than if the samples
selected upon request.

Under certain conditions, however, exceptions
allowed. When purchases amounting to twenty
to be paid for according to the Station's analy
analyses will add to the information of the Statio
strate a possible development of waste products int
plant-food, or in other ways is of general interes
forms the work. In all cases this is done free o
and sufficient particulars are required, so that the
of service to the general public.

The following is a list of those business house
whose goods are published in this report :

Manufacturers

OSE GOODS HAVE BEEN SAMPLED AND ANALYSED THIS YEAR.

len & Son......Lawrence Station, N. J.
n Manufacturing Co......Allentown, Pa.
n Agricultural Chemical Co ......26 Broadway, New York City.
dley Branch......No. 92 State St., Boston, Mass.
copee Guano Branch......No. 88 Wall St , New York City.
k's Cove Branch ......No. 81 Fulton St., New York City.
cker Branch......No 56 Pearl St., Buffalo, N. Y.
India Branch......No 93 William St., New York City.
at Eastern Branch......Rutland, Vt.
som Branch......No. 963 William St., East Buffalo, N. Y.
ific Guano Branch......No. 27 William St., New York City.
ker's Union Branch......No. 150 Nassau St., New York City.
o Phillips Branch ...... No. 710 The Bourse, Philadelphia, Pa.
ston Branch......Greenpoint, L. I., N. Y.
nnipiac Branch......No. 83 Fulton St., New York City.
d Branch......No 16 Exchange Place, New York City.
rpless & Carpenter Branch......No. 710 The Bourse, Philadelphia, Pa.
quehanna Branch......Baltimore, Md.
ert-Allen Branch......No. 2 Chestnut St., Philadelphia, Pa.
eeler Branch......Rutland, Vt.
liams & Clark Branch......No. 27 William St., New York City.
Fertilizer Works......Baltimore, Md.
Atkinson......Mullica, Hill N. J.
ird......Marlboro, N. J.
Sons Co......No. 20 S. Delaware Ave., Philadelphia, Pa.
g Co...... Russell and Bath Sts., Philadelphia, Pa.
Bros......Easton, Pa.
Fertilizer Co......No. 43 Chatham St., Boston, Mass.
& Green Fertilizer Co......Ninth St. and Girard Ave., Philadelphia, Pa.
Brown......Cedarville, N. J.
rk & Son......Mount Ephraim, N. J.
Coe Co......No. 133 Front St., New York City.
Collins & Son......Moorestown, N. J.
Pancoast......Merchantville, N. J.
oper's Glue Factory......No. 13 Burling Slip, New York City.
H Corson......Plymouth Meeting, Pa.
rtelyou......Neshanic Station, N. J.
rtis ......Frenchtown, N. J.
olson & Co ......Woodstown, N. J.
maris & Son......Cedarville, N. J.
enise......Freehold, N. J.
oughten......Moorestown, N. J.
wnward & Co......Coatesville, Pa.
mmons......Newton, N. J.

J. C. Fifield & Sons Co. ....
Fithian & Pennell ....
W. O. Garrison. ....
J. C. Griscom ....
Wyckoff Hendrickson ....
S. M. Hess & Bro .... 4th and Chestnut Sts,
G. C. Higgins & Son ....Th
Ira Hill ....
Hill & Co ....
Hires & Co. ....
W. B. Hitchner ....
The Hubbard Fertilizer Co. .... Merchants' Bank Buildin
International Seed Co. ....
John Joynt .... Lucknow
Kirkwood Marl Co. ....
Hervey Kuhl. ....
Lackawanna Fertilizer and Chemical Co. ....
Samuel Lederer & Sons .... New
Lister's Agricultural Chemical Works. ....
The Mapes F & P Guano Co. .... No. 143 Liberty St
John E. Minch. ....
Mitchell Fertilizer Co. ....
Mixner & Mickel ....
Monmouth Fertilizer Works ....
L. Moritz .... No. 1321 N. 5th St.,
The Nassau Fertilizer Co. .... No. 5 Beaver St
O. F. Neidt .... White Horse Stati
Albert Nelson & Co. ....
New Jersey Agricultural Chemical Co. ....
Newport Fertilizer Co .... No. 407 Drexel Building,
James E. Otis. ....
R. R. Outcalt .... New
S. L. Pancoast.. .... M
Peterson & Smith ....
R. H. Pollock .... No. 51 S. Gay S
Quaker City Poudrette Co .... No. 19 N. Juniper St.,
John Repp ....
Enos Richmond ....
Edward Rigg, Jr. ....
M. F. Riley ....
Ruckman Bros .... New
C. W. Saul ....
Sharpless & Bro. ....
M. L. Shoemaker & Co. .... Delaware Ave. and Venango St.,
Lester Shurts. .... Nesh
L. W. Sickler. ....
Jos. Smith & Co ....
Rufus W. Smith ....
Somerset Chemical Co. .... B

'aylor............Vineland, N. J.
Bros............Camden, N. J.
lor Provision Co ....Trenton, N J.
omas & Son Co. ....No. 2 S. Delaware Ave., Philadelphia, Pa.
Bone Fertilizer Co... ....Trenton, N. J.
. Tygert Co ....No. 42 S. Delaware Ave., Philadelphia, Pa.
d Grain Co............Vineland, N. J.
addington............Salem, N. J.
ahl Manufacturing Co...No. 3870 Pulaski Ave., Nicetown, Philadelphia, Pa.
Wells ....Moorestown, N. J.
eroth & Sons............Camden, N. J.
rsey Marl and Transportation Co............Woodbury, N. J.
Vhann............William Penn, Pa.
Rock Lime Co............McAfee, N. J.
le............Vineland, N. J.
ottom, Carter & Co............Egg Harbor City, N. J.
rd & Dixon (Brokers)............New York City.
ville Lime Co............Wrightsville, Pa.
: Hoffman............White House, N. J.

inspection of fertilizers this year has required the following es:

394	samples	of	Complete Commercial Mixtures,
28	"	"	Incomplete Commercial Mixtures,
26	"	"	Ground Bone,
60	"	"	Fertilizing Raw Materials,
3	"	"	Home Mixtures,
20	"	"	Specially Compounded Mixtures,
20	"	"	Sundry Materials,
5	"	"	Complete Fertilizers of last year's stock.
556			

analyses do not reveal any flagrant attempt at fraud, although ıde preparation of many brands, and the variations which when duplicate samples are analysed, would indicate that a rable proportion of those engaged in the business are not ed of the ordinary facilities required to secure a proper nical condition or uniformity, or they do not have a proper ation of the importance of these points. On the other hand, le variations in the cost per pound of the constituents in the nt brands, even in brands from the same manufacturer, and t that certain brands are able to stay on the market, would e that farmers as a class are prone to consider fertilizers by ne or by the bag, and do not properly appreciate the guarantee e determinative effect it should have on the price demanded. there have been shortages in the amount of plant-food

delivered, the fraud, when there has been one, has in
perpetrated by the farmer upon himself in buying
market.

Farmers should aim to reduce the cost of their f
to as near Station's schedule of prices as possible, f
these are the prices at which not only raw mat
finished mixtures have been purchased this year. I
an analysis from which to compute the valuation, the
be used. Valuing ammonia at $3 for every whole
guarantee, and available phosphoric acid and actual
at $1 each, a rough valuation may be reached f
actual price should not depart materially. In this
tilizer guaranteed to contain 3 per cent. of ammonia
available phosphoric acid and 7 per cent. of actual
furnish ammonia (or nitrogen) worth $9, phosphoric
and potash worth $7, or plant-food worth a total
These are the figures at which it has actually been f
average in twenty mixtures made by regular manuf
factories, but on special order in relatively large lo
organizations, and for cash. While these features ha
had their influence in rendering the prices so favo
numerous instances of very good bargains in the rea
On the average, however, the prices of the latter ra
show an advance of $6.34 per ton over manufacture
in their special brands. These special brands are
grade than the average complete fertilizer; comparin
an equal quantity of plant-food, we may say that a
twenty dollars' worth at Station's valuation has cos
specially mixed and $25.94 in the regular bran
average figures, and two-thirds of the manufacturers s
brands at this rate. On the other hand, there a
manufacturers who furnish twenty dollars' worth o
from $26 to $32, and three charge from $32 upwa
asking $41.40 for twenty dollars' worth, or more th
$15 more than two-thirds of the manufacturers' charg

From these considerations, it will appear that t
decided financial gain from the use of good business
purchase of fertilizer supplies, as well as in the sa
which results; caution in this respect should not
simply because the analysis substantiates the guara
also substantiate the selling price.

2.

E TRADE VALUE OF FERTILIZING INGREDIENTS FOR 1902.

estimated commercial value of fertilizers, it must be clearly ood, is separate and distinct from the agricultural value, the epending upon the character and form of the materials with ce to their availability, and the needs and value of the crop ch they are to be applied. The former, on the other hand, is ned by market and trade conditions, such as supply and de- the cost of production, the methods of manipulation required, is derived by applying to the various forms of plant-food ents, as shown by analysis, the values previously determined or them. These values are fixed from year to year, and are according to the cost of the standard materials containing orms of plant-food, as shown in market reports and actual ions.

wholesale prices of crude products, or raw materials, are every Monday in the well-known trade journal, *The Oil, nd Drug Reporter*. These prices have been tabulated for the ear, and have then been recalculated in order to express them s per pound of actual plant-food, which is the form adopted Experiment Stations of this country. The recalculation has ade upon the basis of the following analyses :

te of Soda	16	per cent.	Nitrogen.
hate of Ammonia	20½	"	"
l Blood	12½	"	"
Phosphate	12	"	Available Phosphoric Acid.
-Grade Sulphate of Potash	50	"	Potash.
le Sulphate of Potash and Magnesia	25	"	"
ate of Potash	50	"	"
it	12½	"	"

count of the fact that the report of the Experiment Station up on October 30th of each year, the results which appear lar form are for the year 1901. During that year the prices nitrogen-furnishing materials fluctuated somewhat, becoming toward the close of the year. As it is probably at this time manufacturers of mixed goods place their contracts for raw ls, the quotations for the last four months of 1901, and the months of 1902, have been averaged as a more suitable basis determination of the schedule of valuations for 1902.

Wholesale Cost, Per Pound, in New York—

MONTHS.	OF NITROGEN IN FORM OF—						OF PHOSPHORIC ACID IN FORM OF—		OF POTASH IN FORM OF—							
	NITRATE OF SODA.		SULPHATE OF AMMONIA.		DRIED BLOOD.		ACID PHOSPHATE.		KAINIT.		MURIATE OF POTASH.		DOUBLE SULPHATE OF POTASH AND MAGNESIA.		HIGH-GRADE SULPHATE OF POTASH.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
January	11.5	11.4	13.8	13.6	14.1	13.9	3.3	3.0	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
February	11.5	11.4	13.7	13.6	14.3	14.3	3.3	3.0	3.8	3.6	3.7	3.7	4.3	4.2	4.2	4.1
March	11.5	11.3	13.6	13.5	14.6	14.6	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2
April	11.5	11.4	13.4	13.0	14.3	14.3	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2
May	11.9	11.5	13.6	13.4	14.3	14.0	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2
June	12.1	11.7	13.4	13.2	14.2	13.9	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2
July	12.3	11.6	13.3	13.2	14.0	14.0	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2
August	12.3	12.0	13.3	13.2	13.9	13.6	3.3	3.0	3.7	3.5	3.7	3.7	4.6	4.5	4.3	4.2

holesale prices per pound of plant-food prevailing in New
ring the six months immediately preceding March 1st last,
nitrogen in nitrate of soda, 12.4 cents, in sulphate of
, 13.8 cents, and in high-grade dried blood, 13.7 cents; for
phosphoric acid in acid phosphate, 3.1 cents; and for actual
n muriate of potash, 3.7 cents, in kainit, 3.6 cents, in
ulphate of potash and magnesia, 4.5 cents, and in high-
phate of potash, 4.3 cents. A comparison of these figures
se of last year will show that there have been advances in
ket prices, particularly of the ammoniates, or nitrogen-
g materials, blood excepted.

these wholesale prices, as a basis, the following schedule of
ues was arranged at a meeting of Station Directors and
for use in Connecticut, Massachusetts, New York, Rhode
ermont and New Jersey during the season of 1902:

dule of Trade Values Adopted by Experiment Stations for 1902.

	Cents per pound.
ogen in Nitrates	15.0
" " Ammonia Salts	16.5
anic Nitrogen in dried and fine-ground fish, meat and blood, and in mixed fertilizers	16.5
" " " fine-ground bone and tankage	16.0
" " " coarse bone and tankage	12.0
sphoric Acid, soluble in water	5.0
" " " " ammonium citrate*	5.0
" " insoluble in fine bone and tankage	4.0
" " " " coarse bone and tankage	3.0
" " " " mixed fertilizers	2.0
" " " " fine-ground fish, cotton-seed meal, castor pomace and wood ashes	4.0
Muriate	4.25
Sulphate, and in forms free from muriates (or chlorids)	5.0

Valuation of Fertilizing Ingredients in Fine-Ground Feeds.

anic Nitrogen	14.5
sphoric Acid	4.0
sh	5.0

bility of phosphates, in ammonium citrate solutions, varies with the degree of heat.
e Legislature (see Laws of New Jersey, 1874, page 90), provides that in this deter-
e temperature used shall not exceed 100° Fahr.; in other States 150° Fahr. has been
onsequently the Station valuation of phosphoric acid, soluble in ammonium citrate
ed at *four and one-half cents* per pound for Connecticut, Massachusetts, New York,
d and Vermont, and at *five* cents per pound for New Jersey.

The Examination of Unmixed Fertilizing M

The results of analysis of sixty samples of standa materials appear in tabulated form upon subseque work is of particular value in that it directs the atten consumers to the composition and use of standard fer and suggests rational and economical methods of pu food. The samples include nitrate of soda, dried b ground fish, tankage, plain superphosphate, muriate potash and kainit. The samples would indicate tha resented were generally of good quality, although t bility is to be seen in the case of blood, fish and greater part of them appear to be economical purchas the usual prominent exceptions. Since the samples actually on the market at the prices given, the average of their several ingredients may be fairly assumed t average prices at factory for nitrogen, phospheric ac These average prices are 14 cents per pound of nitro soda, 16.3 cents in dried blood and the fine-ground 18.2 cents in dried and ground fish, 3.9 cents per pou phosphoric acid in plain superphosphates, and 4.1 ce 4.8 cents per pound of actual potash in muriate of p of potash and kainit, respectively.

The raw materials on the average were, therefore tically at Station's prices, the principal exception b ground fish ; all but two of the samples of this mate samples, and were sold in the same way, and to a same profits as the regular complete fertilizers, whi exception.

3.

THE EXAMINATION OF HOME MIXTURES AND SPECIA

Home mixing by farmers has been carried on with tion for a number of years. The Station has encoura in these efforts as of value to the individuals them object-lesson to their neighbors. Less assistance, b shape of analyses, etc., is now being required of

easons : First, the more experienced have ceased to request ; second, many who mix for themselves mix for their as well and become in a way manufacturers ; their mix- sampled in the regular way, and are published with the rands ; and third, a growing number of individuals, farmers' anges, etc., direct and govern the composition of their but have the mixing done especially for them at the nanufactory.

alyses of three home mixtures and of twenty special mix- published herewith. In certain of the latter, merely the d analysis, which is given in the tables, was required of the urer ; in others, the use of certain ingredients was insisted ingredients of the home mixtures and of the others, reported e as follows :

Composition.

Home Mixtures.

No. 1687.

bs. Dried Fish.
" Ground Bone.
" Acid Phosphate.
" Muriate of Potash.

No. 2724.

bs. Nitrate of Soda.
" Dried Blood.
" Dissolved Tankage.
" Dried Fish.
" Acid Phosphate.
" Ground Bone.
" Muriate of Potash.

No. 2576.

s. Nitrate of Soda.
" Sulphate of Ammonia.
" Dried Blood.
" Degelatinized Bone.
" Acid Phosphate.
" Muriate of Potash.

Special Mixtures.

No. 2399.

400 lbs. Dried Fish.
500 " Steamed Bone.
700 " Acid Phosphate.
400 " Muriate of Potash.

No. 2400.

100 lbs. Nitrate of Soda.
100 " Sulphate of Ammonia.
250 " Dried Fish.
500 " Steamed Bone.
700 " Acid Phosphate.
350 " Muriate of Potash.

No. 2350.

200 lbs. Nitrate of Soda.
400 " Dried Fish.
1,000 " Dissolved Bone.
400 " Muriate of Potash.

lowing table shows the average composition of the Home and Special Mixtures, together with their average value and the difference between the same :

	Total Nitrogen.	Total Phos. Acid.	Available Phos. Acid.	Insoluble Phos. Acid.	Potash.
Home Mixtures.............	2.38	13.77	10.87	2.90	9.76
Special Mixtures...........	2.33	10.67	8.02	2.65	7.0

The home mixtures, therefore, cost on the aver
Station's valuation, and the special mixtures $1.44
of $3.81.

Inasmuch as most of the unmixed materials co
this year were purchased at average prices equal
tion, the cost of the three home mixtures was
rather than $3.81, may be considered as the
these instances for the labor of mixing and re-
mixtures, it being assumed that the other expen
either case. The actual charge in the case of the
tions, which may be learned by an inspection of t
the actual financial advantage gained by each ind
home-mixing or special mixing to order. Of cou
cultural advantage is to be derived from the possi
the composition or formula, which pre-supposes a
part of the farmer, of the needs of his soil and c
saving by these methods is great; to secure it, th
business-like methods of purchase, based upon a
state of the fertilizer market.

4.

THE EXAMINATION AND VALUATION OF MANUFACTU
CELLANEOUS PRODUCTS AND SUNDRY MA

The object of this, the main fertilizer work of
determine by chemical analysis whether the *actual* c
of the various manufactured products corresponds
composition, as required by law, whereby it is s
material fulfills the claims of the manufacturer a
the guarantee given is a guide to the amounts of p
to the consumer. In addition, the application
values for the several forms of plant-food, as g

relatively the manufacturing or first cost of the individual hich may be directly compared with the selling prices to harges of the manufacturer for mixing, bagging and other n effecting their sale.

rk is of twofold value :—*direct*, in that it furnishes the d experienced purchaser with information as to the compo- cost of the brands to which his attention may be drawn ; *ct*, in its restraining influence, whereby worthless material lly kept away from our markets.

1. Complete Fertilizers.

samples of complete fertilizers, the analyses of which are eported, represent 391 distinct commerical brands, which eight more than last year. Three brands appear in dupli- ich case the manufacturer claimed that the original sample present the true character of the goods, and another sample ore examined ; as both samples represent large stocks, both ave been published. The 391 brands are the product of establishments, if the branches of the American Agricul- nical Company be considered separately. There is, there- nly a greater number of manufacturers represented than when the number was seventy-nine, but also a larger aver- entation. This amounts to about two additional brands en manufacturers, so that the average representation per rer is four and one-tenths brands this year, as compared and nine-tenths brands in 1901, and three and six-tenths 1900. The average number of brands apiece, therefore, is there are sixty-five manufacturers each represented by er or less, twenty by from five to eight (twice the average), rom nine to thirteen (three times the average), and three ourteen to eighteen (or four times the average). It is note, that eighty-four of the ninety-five manufacturers put rket two-thirds of the number of brands with an average ion of three and one-tenths brands apiece.

Brand Names.

ent to which multiplication of brands is in some cases uld seem to be in excess of that needed for a range of ecially in those cases when the differences, to all practical

purposes, are in name only. It may be, however
demands this, for it is undeniably true that wit
consumers the name still has considerable influe
This is all the more remarkable when we consider
names carry no exact information in themselves,
attempted how few manufacturers agree as to th
for any specified crop. On the one hand, the
Queen" or "Farmer's Pride," in themselves give
and on the other, practically one-third of the great
examined this year are specially designated for pot

A cursory examination of these will show that
select for potatoes brands which the manufacturers
(as shown by their guarantees of ammonia, ava
acid and potash), 1, 6, 4 per cent., 2, 8, 10 per
cent., 4, 6, 10 per cent., 5¼, 8, 8 per cent., 4, 9, 7
per cent., 2, 10, 4 per cent., or 1, 4, 8 per cent. of
or almost any other combination of figures. With
of exceptions, the theory of special fertilization i
the same brands are designated not only for pota
beans, cabbage, tobacco, hops, corn, general truc
until it would seem that rational procedure would
out all but this last, and simply say "for general u

For the purchaser, therefore, the necessity may
the printed statement of analysis or guaranteed co
brand which is required by law, and the importa
ity of the actual composition with it.

Guarantees and Actual Compositio

Without exception, every brand examined thi
accompanied by a guarantee, as the fertilizer law c
quires shall accompany all packages or lots of o
pounds sold, offered or exposed for sale. It will
tables, however, that in a little over one-half of the sa
tee of phosphoric acid is defective, either available o
acid alone being guaranteed. The absence of gua
certain instances is commercially not of great imp
available is given, since the surplus which goes to
is insoluble and comparatively inexpensive. Agr
ever, when consumers scrutinize guarantees, in orde
in which the quickly-available phosphoric acid is a

amount of the more slowly-available, the guarantee giving ormation becomes of particular value. But when, on the nd, total phosphoric acid alone is guaranteed, there is no ion whatever afforded as to its availability—a very important n the choice of a fertilizer. Among the samples examined , there are twenty-two cases in which the latter is the case. of these, no great amount of available should be expected, y are intended as slowly-acting manures and consist of fish sh, bone and potash, etc. In most of the others there is a unt of available, and the manufacturer is losing credit for ds by not claiming it. As this may not always be the case, rs should insist upon a complete compliance with the law ey consent to purchase.

tiny of the analysis of each brand, and a careful comparison tual composition, with its accompanying guarantee, show ut 31 per cent. of them are deficient in one or more of the forms of plant-food. The deficiencies, compared with those ast seven years, are shown in the following table. In com- is table, deficiences in nitrogen to the extent of 0.20 per d in phosphoric acid and potash to the extent of 0.30 per e been ignored :

	Number of Brands.				Deficiencies possible.	Actual Deficiencies.			
	Examined.	Found as guaranteed.	Found deficient.	Percentage deficient.		Nitrogen.	Phosphoric Acid.	Potash.	Percentage.
....	269	158	111	41	807	17	72	37	15.6
....	329	211	118	36	987	30	52	56	14.0
....	284	194	90	32	852	29	47	30	12.4
....	303	201	102	34	909	43	29	49	13.3
....	321	222	99	31	963	33	51	32	12.0
....	298	214	84	29	894	33	35	31	11.1
....	308	202	106	35	924	31	60	34	13.5
....	391	269	122	31	1,173	44	54	49	12.5

As indicated in the table, there are 147 deficie
among 122 brands, nineteen brands being deficient i
and three brands in all three particulars of their guar
is a total of 1,173 deficiences possible in the 391 bra
follows, therefore, that 12½ per cent. of these possibili
occurred. This percentage would be larger were it
ance of 0.20 and 0.30 per cent. referred to, where
would be classed as deficient in more particulars tha

The average valuation of those which do not mee
is $21.57, and of those which do, $21.21, and the
prices are $28.78 and $27.16, showing that the de
occur in the low-priced or high-priced goods as a c
ences between valuation and selling price, $7.21 and
show the financial advantage of buying only those
up to guarantee, as the saving would on the average
an immediate discount of 4 per cent. on the money

Station's Valuations and Selling Pri

The Station's valuation per ton is derived by
different constituents the schedule of prices alread
intended to show the retail cash cost of the amo
phosphoric acid and potash contained in one ton if
at factory in the form of raw materials, unmixed.
between selling price and Station's value shows, the
that is made for mixing, bagging, shipping and s
brands.

The selling price per ton entered in the table i
point where sampled. These prices differ in the va
the State, due mainly to differences in freight rat
production to consumers' depot, the amount sold
charged. Nothing has been added to the valuati
these charges, the Station preferring to let the con
calculations himself, whereby they will apply to hi

The average composition, estimated value and se
of the brands of complete fertilizers examined each
twelve years, together with the actual and the perc
by which the selling price exceeds the valuation, a
following tabulation :

R.	Total Nitrogen.	Total Phos. Acid.	Available Phos. Acid.	Insoluble Phos. Acid.	Potash.	Station's Valuation.	Selling price.	Actual difference.	Percentage difference.
....	2.71	10.12	7.29	2.83	4.21	$25 31	$34 23	$8 92	35.2
....	2.74	10.38	7.70	2.67	4.50	25 66	34 19	8 53	33.2
....	2.69	10.23	7.54	2.69	4.58	24 41	34 11	9 70	39.7
. ...	2.87	10.40	7.37	3.03	4.94	24 83	34 17	9 34	37.6
....	2.80	10.74	7.84	2.90	4.80	24 15	32 87	8 72	36.1
....	2.51	10.86	8.21	2.65	5.02	21 70	30 33	8 63	39.8
....	2.54	10.93	8.01	2.91	5.01	21 58	29 28	7 70	35.7
....	2.45	10.69	8.37	2.32	5.38	19 90	28 58	8 68	43.6
....	2.41	10.58	8.27	2.31	5.67	19 95	27 75	7 80	39.1
....	2.30	11.03	8.44	2.59	5.89	20 77	27 26	6 49	31.2
....	2.31	10.48	8.08	2.40	5.77	21 19	27 31	6 12	28.9
....	2.38	10.47	8.09	2.38	5.32	21 32	27 66	6 34	29.7

be observed that there has been a slight falling off in the potash furnished, and a slight increase in the nitrogen and selling price. The advance in the cost of ammoniates last was met by increases in the Station's schedule, by which the ns have been computed. It becomes of interest, therefore, ate the average valuation for the past two years by means ame schedule. Using last year's schedule, the valuations, d with the selling prices, are shown as follows :

	Station's Valuation.	Selling Price.	Actual Difference.
901..................................	$21 19	$27 31	$6 12
902..................................	21 06	27 66	6 60

pears, therefore, that the manufacturers are delivering, on age, somewhat less total plant-food than in 1901, at a slight per ton.

g the valuations and selling prices as they are, however, the difference is $6.34, which represents the average charge of e number of manufacturers for mixing and bagging an aver- bout $21 worth of plant-food, and for dealers' commissions r expenses incurred in effecting its sale and delivery. This is ly 30 per cent. of the value delivered; that this average charge ade in all cases is apparent from an examination of the tables, will be found that sixty-four, or two-thirds of the manu- , are represented by brands which furnish plant-food at an ranging below 30 per cent.; twenty-eight from 30 to 60 per

cent. and three from 60 per cent. upwards, the hi
ing 107 per cent. advance over the cost of an e
plant-food in the form of standard raw materials.

2. Ground Bone.

The twenty-six samples of ground bone examine
good quality, and with a few exceptions were as gua
at prices very close to Station's valuations. In
samples run from 1.28 to 4.87 per cent. of nitrogen
to 29.64 per cent. of phosphoric acid. There is sor
tion between the two, a high nitrogen content bein
panied by a low phosphoric acid, and *vice versa*, bu
not mathematically perfect. In the finest sample,
pass a one-fiftieth-inch sieve, and in the coarsest onl
The average fineness and composition of the sam
compared with 1899, 1900, and 1901, is shown as fo

	Fine, Per Cent.	Coarse, Per Cent.	Nitro Per C
Average for 1899	49	51	3.1
" " 1900	63	37	3.2
" " 1901	52	48	3.2
" " 1902	57	43	3.0

There was no change in the Station's schedule for
bone this year; the average valuations for the past
fore, may be directly compared with each other, and
prices, as follows:

	Station's Value.	Selling Price.
Average for 1901	$26 09	$28 98
" " 1902	26 85	26 97

Average ground bone this year, therefore, value
and sold $2 cheaper than last year, so that the
over Station's valuation was only twelve cents a ton
of the table of analyses, however, will show a few in
tions, as high a price as $35 being reported for a bra
at exactly $26.

3. Miscellaneous Fertilizers and Sundry Materials.

ıe twenty-eight samples of miscellaneous fertilizers, one is a te sample, six are plain superphosphates, eighteen are plain ıosphates with potash, and three furnish phosphoric acid and ı. In the case of nineteen of these materials, the brand name s an allusion to bone. Purchasers of these materials should mind that the presence of the word "bone" in the brand ıeans nothing whatever; true bone furnishes nitrogen and no oluble phosphoric acid, and when a material purports to be ıl bone," and does not conform to these requirements, it is e bone. This is the case in all but two of the nineteen , the exceptions being in one case a true manipulated bone, the other a mixture of bone with acid phosphate. In calling n to this, the Station does not intend to discriminate against of acid phosphate, of which most of these materials consist, inst the *purchase* of it as bone or at bone prices, which have ked in three cases in particular.

 the materials were accompanied by guarantees; these were except in the case of six samples, which were low in their e. With a few exceptions these materials are expensive of plant-food. The acid phosphates, on the average, fur- available phosphoric acid at five and seven-tenths cents per equal to $16 per ton for 14 per cent. available, whereas it is n an earlier portion of this report that acid phosphate of that lity has been purchased at an average of $11 per ton. The ng samples, on the average, and excluding No. 2577, fur- plant-food worth at Station's valuations $13.68, for an aver- e of $19.20, an advance of $5.52, or over 40 per cent., the average complete fertilizer only exceeds valuation by 30 .

undry materials examined include four samples of wood ne of lime kiln ashes and four of lime. While the first five phosphoric acid and potash, and one sample of prepared ntains potash, the important feature in all of these materials ıly the presence but also the active form of the lime. The cial value of this is dependent upon the price of lime in the rhood where it is desired; the Station's valuations are based on the phosphoric acid and potash at four and five cents per respectively.

The remainder of the sundry materials are factory w
products, which were examined to determine their cha
of plant-food. They include three samples of tanner
each of garbage ashes, oil-cake waste, wool waste, soo
a so-called "unnamed" fertilizer, tobacco stems an
guano.

FORMS OF NITROGEN.

Readily and Completely Soluble in Water.

FROM WHOM RECEIVED.	Percentage of Nitrogen.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Material.
rate of Soda.	%	cts.	
J. S. Collins & Son, Moorestown	15.46	*15.52	$48 00
S. L Pancoast, Mullica Hill	15.64	13.27	41 50
W. Davis, Cedarville	14.22	*15.47	44 00
H. Schnitzer, Fairton	15.42	14.59	45 00
W. Saalman, Egg Harbor City	15.65	13.80	43 20
College Farm	15.76	14.28	45 00
Mixner & Mickel, Bridgeton	15.51	*17.73	55 00
J. G Schanck, Keyport	15.49	*17.75	55 00
J. W. Pincus, Woodbine	16.18	13.02	42 00
J. Q. Holcombe, Ringoes	15.54	14.91	46 35
Average Cost per Pound		13.98	

FORMS OF NITROGEN INSOLUBLE IN WATER.

FROM WHOM RECEIVED.	Percentage of Nitrogen.	Percentage of Phosphoric Acid.	Cost of Nitrogen per lb.	Cost of 2,000 lbs. of Material.
d Blood.	%	%	cts.	
College Farm	10.58	3.37	15.26	$35 00
J. Y. Dilatush, Robbinsville	13.10	0 62	18.13	48 00
J. B. Warwick, Hartford	12.75	0.00	15.69	40 00
Average Cost per Pound			16.31	
d and Ground Fish.				
Hopkins & Lippincott, Moorestown	5.29	3.68	*19.00	23 00
J. S. Collins & Son, Moorestown	8.56	6.38	17.47	36 00
H. Clement, Woodbury	8.17	7.15	17.92	35 00
" "	6.94	5.79	20.44	38 00
Henry Stanley, Westville	9.20	1.02	*17.49	33 00
J. Hoenes, Cologne	7.18	6.00	19.78	33 00
" "	7.85	7.62	15.22	30 00
W. Saalman, Egg Harbor City	8.77	6.10	16.15	33 20
Mixner & Mickel, Bridgeton	9.04	5.05	17.12	35 00
J. Strickland, Jackson's Mills	5.04	7.01	23.20	29 00
F. H. Macfarland, Hammonton	7.82	5.92	17.43	32 00
J. Q. Holcombe, Ringoes	8.63	6.40	17.31	35 00
Average Cost per Pound			18.20	

cluded in the average.
Crab.
und.
Fish.

FORMS OF NITROGEN INSOLUBLE

TANKAGE.

Station Number.	FROM WHOM RECEIVED.	MECHANICAL ANALYSIS. Finer than 1/50 inch.	Coarser than 1/50 inch.
2174	W. Wilde, Vineland	18	82
2204	W. Saalman, Egg Harbor City	51	49
2220	College Farm	53	47
2252	Mixner & Mickel, Bridgeton	47	53
2348	H. H. Riggs, Hightstown	54	46
2402	J. Y. Dilatush, Robbinsville	32	68
2503	Ira Hill, Copper Hill	41	59
2504	" " " "	23	77

TANKAGE.

Station Number.		COST OF NIT PER LB. I Finer than 1/50 inch.	
		cts.	
2174	Tankage	*28.28	*
2204	"	15.12	
2220	"	14.08	
2252	"	*25.80	*
2348	"	15.76	
2402	"	16.52	
2503	"	18.96	
2504	"	17.68	
	Average Cost per Pound	16.35	1

*Not included in the average.

PLAIN SUPERPHOSPHATES.

urnishing Soluble, Reverted and Insoluble Phosphoric Acid.

FROM WHOM RECEIVED.	PHOSPHORIC ACID.				Cost of Available Phosphoric Acid per lb.	Cost of 2,000 lbs. of Material.
	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Available.		
	%	%	%	%	cts.	
ns, Moorestown	10.76	2.45	1.89	13.21	3.78	$10 00
ssup, Moorestown	11.76	3.14	1.62	14.90	2.77	8 25
e, Vineland	10.86	3.64	1.67	14.50	4.14	12 00
nan, Egg Harbor City	10.70	4.11	1.60	14.81	3.61	10 70
Farm	11.32	2.74	3.98	14.06	3.56	10 00
& Mickel, Bridgeton	10.82	2.67	3.79	13.49	4.45	12 00
iggs, Hightstown	11.38	2.59	2.40	13.97	4.29	12 00
ncus, Woodbine	10.68	3.36	1.80	14.04	3.33	9 35
lcombe. Ringoes	12.04	1.83	0.09	13.87	3.66	10 15
afer, Milford	8.24	4.68	2.18	12.92	*5.80	15 00
tter, Belvidere	12.90	3.28	2.28	16.18	4.33	14 00
Flemington	10.20	2.78	3.47	12.98	4.62	12 00
s, Neshanic Station	12.10	2.33	2.61	14.43	4.50	13 00
verage Cost per Pound					3.92	

uded in the average.

GERMAN POTASH SALTS.

FROM WHOM RECEIVED.	Percentage of Potash.	Cost of Potash per lb.	Cost of 2,000 lbs. of Material.
te of Potash.	%	cts.	
A. Bennett, Cranbury	51.31	3.70	$38 00
L. Pancoast, Mullica Hill	50.17	4.13	41 50
Davis, Cedarville	55.15	3.90	43 00
Wilde, Vineland	50.97	4.12	42 00
llege Farm	49.86	4.01	40 00
xner & Mickel, Bridgeton	53.35	4.22	45 00
Hill, Copper Hill	50.49	4.16	42 00
W. Pincus, Woodbine	46.39	4.20	39 00
Q. Holcombe, Ringoes	48.44	4.13	40 00
s. Yetter, Belvidere	51.44	4.37	45 00
ndy Bros., Bound Brook	46.76	4.64	43 40
Average Cost per Pound		4.14	
Grade Sulphate of Potash.			
W. Pincus, Woodbine	43.62	5.04	44 00
t.			
ylor Bros., Camden	12.83	4.87	12 50
xner & Mickel, Bridgeton	12.71	4.72	12 00
Average Cost per Pound		4.80	

Home Mixtures and Special Com

Furnishing Nitrogen, Phosphoric Acid and

MANUFACTURER AND BRAND.	WHERE
HOME MIXTURES.	
J. H. Higgins, Barley Sheaf	Barley Shea
L. E. Savacool, Newton	Newton
J. B. Warwick, Hartford (Moorestown Grange)	Hartford
SPECIAL COMPOUNDS.	
The Nassau Fertilizer Co., New York City.	
Pomona Grange Mixture No. 1	Harmony
" " " No. 2	"
Newport Fertilizer Co., Philadelphia, Pa.	
Coffin Brand	Ashland
Gloucester County Grange Sweet Potato Fertilizer	Swedesboro
" " " White Potato Fertilizer	"
Egan's Formula	Moorestown
Hilton Brand	Hartford
Pomona Grange Potato Mixture	Harmony
" " Grain Mixture	"
Somerset Chemical Co., Bound Brook, N. J.	
Amerman's No. 2 Special	Neshanic
" No. 3 "	"
I. P. Thomas & Son Co., Philadelphia, Pa.	
Roxburg Grange Mixture	Brainards
Trenton Bone Fertilizer Co., Trenton, N. J.	
Silvers & Hutton Brand	Cranbury
Williams & Clark Branch, New York City.	
Blawenburg Grange No. 1	Blawenburg
" " No. 2	"
Grand View Grange Mixture No. 1	Flemington
" " " " No. 2	"
Millstone Grange Mixture No. 1	Millstone
" " " No. 2	"
" " " No. 4	"

ne Mixtures and Special Compounds

rnishing Nitrogen, Phosphoric Acid and Potash.

		Phosphoric Acid.							Potash.			
							Available.					
	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
3	......	4.96	6.36	4.95	16.27	....	11.32	....	6.54	....	†$22 16	$20 37
9	3.28	3.34	6.18	1.40	10.92	....	9.52	8.50	12.87	12.00	30 31	28 00
2	......	2.52	9.26	2.33	14.11	....	11.78	....	9.88	....	31 40	25 50
2	2.05	4.00	4.12	2.42	10.54	9.00	8.12	8.00	6.48	6.00	21 48	19 75
5	0.82	3.88	4.76	2.40	11.04	10.00	8.64	9.00	5.17	5.00	16 13	14 50
9	2.46	4.28	1.89	3.17	9.34	....	6.17	6.00	*9.74	12.00	25 63	32 00
7	2.05	7.26	1.66	2.91	11.83	......	8.92	6.00	9.05	10.00	23 94	25 61
3	3.49	6.88	2.07	2.80	11.75	10.00	8.95	6.00	8.39	8.75	26 99	26 00
3	3.69	6.16	3.79	0.75	10.70	....	9.95	7.00	11.30	10.00	36 91	31 85
5	3.28	4.04	1.81	2.78	8.63	....	5.85	7.00	10.45	10.00	24 88	29 00
0	2.46	6.88	1.59	2.73	11.20	....	8.47	7.50	*6.00	8.00	21 76	24 10
0	2.46	7.26	2.03	3.34	12.63	....	9.29	9.00	*2.31	2.00	19 26	19 35
5	1.64	0.00	7.26	3.57	10.83	....	7.26	8.00	4.25	5.00	†17 98	25 00
5	0.82	0.02	6.63	3.74	10.39	....	6.65	10.00	3.58	4.00	†13 91	20 00
5	2.50	5.18	4.21	2.82	12.21	....	9.39	8.00	4.59	5.00	†21 30	19 00
5	4.10	3.56	5.03	1.78	10.37	....	8.64	8.00	10.08	10.00	31 15	35 00
0	0.82	6.04	3.64	2.07	11.75	10.00	9.68	9.00	7.11	7.00	†19 72	19 25
0	2.05	1.92	5.71	3.15	10.78	....	7.63	8.00	6.03	6.00	†20 65	23 40
7	1.64	2.82	5.15	3.09	11.06	9.00	7.97	8.00	10.34	10.00	25 23	28 00
5	1.23	2.12	4.35	2.68	9.10	7.00	6.47	6.00	6.16	5.00	21 51	25 00
0	1.23	1.82	5.42	2.82	10.06	....	7.24	8.00	4.92	5.00	18 13	20 00
7	2.46	4.02	3.47	1.51	9.00	....	7.49	6.00	9.07	10.00	22 58	25 00
0	2.46	3.90	3.78	2.64	10.27	....	7.63	8.00	7.98	6.00	26 10	28 00

, if not entirely, in form of sulphate. † 1901 valuation.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid a

MANUFACTURER AND BRAND.	WH
J. H. Allen & Son, Lawrence Station, N. J.	
Bone and Potash	Lawre
Complete Phosphate	"
Potato and Truck Manure	"
American Agricultural Chemical Co., New York City.	
Bradley Branch.	
New Method Fertilizer	Keypo
Potato Fertilizer	Belvid
Complete Manure for Potatoes and Vegetables	Freeho
Complete Manure with 10 Per Cent. Potash	Keypo
Potato Manure	Roselle
Bean and Potato Phosphate	"
Niagara Phosphate	Afton ..
Chicopee Guano Branch.	
A 1 Vegetable and Potato Manure	Cold S
Special New Jersey Brand	Lyons
Standard Guano	"
Farmers' Reliable	Westw
Clark's Cove Branch.	
Fish and Potash	Keypo
Great Planet	Plainsb
Crocker Branch.	
Wheat and Corn Fertilizer	Paterso
Cabbage and Potato Manure	Turkey
Special Potato Manure	Holmd
Harvest Jewel Fertilizer	Paterso
East India Branch.	
Baker's Complete Manure for General Use	West L
" Potato Manure	Marlbo
" Turnip Manure	Red Ba
" "AA" Ammoniated Superphosphate	" "
" Standard UnXld Fertilizer	Plainsb
" Harvest Home Phosphate	Morrist
Great Eastern Branch.	
Vegetable, Vine and Tobacco	Blackw
Garden Special	"
Northern Corn Special	Princet
General	Baskin
Wheat Special	"

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

gen.		Phosphoric Acid.					Available.		Potash.			
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
3.23	2.46	0.04	9.28	7.22	16.49	15.75	9.27	....	3.28	3.00	$25 61	$25 00
2.56	2.46	4.52	5.83	2.88	13.23	11.00	10.35	9.00	2.09	2.00	21 52	25 00
3.53	3.28	4.60	3.74	2.18	10.47	10.00	8.34	7.00	10.29	10.00	29 33	32 00
0.99	0.82	4.68	3.78	1.84	10.30	9.00	8.46	8.00	2.25	2.00	14 38	21 00
2.21	2.05	3.96	4.87	2.52	11.35	9.00	8.83	8.00	3.33	3.00	19 96	25 00
3.55	3.28	2.12	5.60	3.44	11.16	9.00	7.72	8.00	7.36	7.00	26 83	29 00
3.26	3.28	3.70	2.12	1.34	7.16	7.00	5.82	6.00	10.59	10.00	26 11	32 50
2.42	2.46	1.64	3.97	3.91	9.52	7.00	5.61	6.00	*6.98	6.00	21 02	35 00
0.88	0.82	5.70	2.62	1.95	10.27	9.00	8.32	8.00	4.39	4.00	15 73	28 00
0.98	0.82	4.30	2.76	2.00	9.06	8.00	7.06	7.00	1.46	1.00	12 33	22 00
2.32	2.46	4.12	3.99	1.94	10.05	9.00	8.11	8.00	6.02	6.00	21 46	25 00
2.66	2.46	5.30	1.51	1.71	8.52	7.00	6.81	6.00	10.32	10.00	25 04	32 50
1.08	0.82	6.32	1.98	2.52	10.82	9.00	8.30	8.00	5.21	4.00	17 30	24 00
0.98	0.82	5.46	2.51	2.61	10.58	8.00	7.97	7.00	1.69	1.00	13 68	21 00
2.28	1.64	4.32	3.44	3.02	10.78	9.00	7.76	8.00	2.26	2.00	18 42	24 00
3.19	3.28	5.94	2.32	1.56	9.82	9.00	8.26	8.00	7.13	7.00	25 29	31 00
2.24	2.05	6.54	1.97	2.66	11.17	9.00	8.51	8.00	2.30	1.50	18 92	24 00
2.53	2.46	6.62	1.66	2.10	10.38	9.00	8.28	8.00	6.47	6.00	22 97	29 00
2.70	3.28	7.04	1.53	1.72	10.29	9.00	8.57	8.00	7.78	7.00	24 65	30 00
1.74	1.64	5.90	1.94	2.23	10.07	9.00	7.84	8.00	2.86	2.00	16 83	22 00
2.39	2.46	3.54	4.16	2.51	10.21	9.00	7.70	8.00	5.71	6.00	21 44	31 00
3.46	3.28	3.82	1.88	1.55	7.25	7.00	5.70	6.00	10.45	10.00	26 62	34 00
5.37	5.74	3.76	1.61	2.22	7.59	6.00	5.37	5.00	8.91	9.00	31 55	40 00
2.67	2.46	6.36	2.97	1.84	11.17	11.00	9.33	9.00	2.33	2.00	20 90	30 00
2.34	2.05	4.16	3.68	3.20	11.04	9.00	7.84	8.00	3.29	3.00	19 51	26 00
1.31	1.03	3.04	4.86	3.30	11.20	9.00	7.90	8.00	2.02	2.00	15 26	25 00
2.01	2.05	5.60	2.57	1.28	9.40	9.00	8.17	8.00	3.18	3.00	17 99	25 00
3.26	3.28	5.56	2.70	1.71	9.97	9.00	8.26	8.00	6.76	7.00	25 44	33 00
2.59	2.46	4.38	3.99	2.48	10.80	11.00	8.37	9.00	2.10	2.00	19 68	25 00
1.00	0.82	7.24	2.89	1.97	12.10	9.00	10.13	8.00	4.17	4.00	17 77	23 00
1.85	1.64	7.14	2.34	2.40	11.88	9.00	9.48	8.00	2.48	2.00	18 66	24 00

rgely, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid an

MANUFACTURER AND BRAND.	WHE
American Agricultural Chemical Co.—(Cont.)	
Milsom Branch.	
Blood, Bone and Potash Fertilizer	Cranbu
Buffalo Guano	Paterso
Potato, Hop and Tobacco Fertilizer	"
Vegetable Bone Fertilizer	Stillwat
Corn Fertilizer	Newton
Pacific Guano Branch.	
Special Potato Manure	Hightst
Nobsque Guano	"
Potato Phosphate	"
A No. 1 Phosphate	Milling
Ammoniated Dissolved Bone	Martinv
Packers' Union Branch.	
Gardeners' Complete Manure	Mt. Eph
Potato Manure	"
Universal Fertilizer	Elizabe
Animal Corn Fertilizer	Hopewe
Moro Phillips Branch.	
Fish Guano	Westvil
New Jersey Potato Manure	Cold Sp
Special Fertilizer	Fishing
C. and G. Complete Fertilizer	Cold Sp
Preston Branch.	
Ammoniated Superphosphate	Egg Ha
Potato and Onion Fertilizer	Hambu
Corn Fertilizer	Freehol
Corn Guano	"
XXV Fertilizer	Fairmo
Read Branch.	
Vegetable and Vine Fertilizer	Florenc
Potato Manure	Prospec
Farmers' Friend	Pomona
Bone, Fish and Potash	"
Leader Blood and Bone	Three B
Standard Superphosphate	English
High-Grade Farmers' Friend	Prospec
Practical Potato Special	Three B
Truck Fertilizer	Blairsto

Complete Fertilizers

...rnishing Nitrogen, Phosphoric Acid and Potash.

...n.		Phosphoric Acid.							Potash.			
							Available.					
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.38	3.28	5.04	2.39	1.84	9.27	7.00	7.43	6.00	10.16	10.00	$27 81	$29 00
.21	0.82	4.76	3.34	1.66	9.76	9.00	8.10	8.00	4.26	4.00	16 37	24 00
.28	2.05	3.98	4.29	2.64	10.91	9.00	8.27	8.00	3.37	3.00	19 72	26 00
.50	3.28	4.58	3.51	2.18	10.27	9.00	8.09	8.00	7.27	7.00	26 48	30 00
.53	2.46	6.52	3.00	2.02	11.54	11.00	9.52	9.00	2.30	2.00	20 64	22 00
.52	2.46	3.38	2.86	2.74	8.98	7.00	6.24	6.00	7.39	6.00	21 94	32 00
.20	1.03	4.42	3.93	2.15	10.50	9.00	8.35	8.00	2.48	2.00	15 28	22 00
.64	1.23	2.30	3.74	3.61	9.65	7.00	6.04	6.00	5.05	5.00	17 18	25 00
.11	0.82	2.00	4.29	3.07	9.36	8.00	6.29	7.00	1.40	1.00	12 37	18 00
.73	1.64	5.28	2.79	2.59	10.66	9.00	8.07	8.00	2.12	2.00	16 62	22 00
.18	3.28	4.14	2.73	0.75	7.62	7.00	6.87	6.00	10.61	10.00	26 62	32 00
.12	2.05	6.04	3.00	1.55	10.59	9.00	9.04	8.00	5.49	6.00	21 25	27 00
.14	0.82	6.08	2.34	2.61	11.03	9.00	8.42	8.00	4.57	4.00	17 11	23 00
.44	2.46	7.96	2.24	1.77	11.97	11.00	10.20	9.00	2.90	2.00	21 29	24 00
.79	1.85	1.02	3.65	1.44	6.11	6.00	4.67	5.00	1.41	1.00	12 26	19 00
.60	1.64	5.98	2.10	1.16	9.24	9.00	8.08	8.00	10.22	10.00	22 51	29 00
.12	2.05	5.96	2.24	1.02	9.22	9.00	8.20	8.00	3.19	3.00	18 32	18 50
.87	0.82	5.50	2.89	1.38	9.77	9.00	8.39	8.00	2.33	2.00	13 79	19 00
.38	2.46	4.82	3.85	2.36	11.03	11.00	8.67	8.00	2.18	2.00	19 31	25 00
.54	2.46	3.96	2.54	2.13	8.63	7.00	6.50	6.00	6.38	6.00	21 15	29 00
.53	2.46	4.56	3.30	2.11	9.97	9.00	7.86	8.00	*6.54	6.00	22 77	26 00
.24	1.64	3.50	4.42	3.28	11.20	9.00	7.92	8.00	3.22	3.00	19 36	21 00
.26	0.82	5.36	1.98	2.32	9.66	8.00	7.34	7.00	1.43	1.00	13 69	19 00
.93	2.05	6.30	2.04	1.38	9.72	9.00	8.34	8.00	5.66	6.00	20 07	28 00
.54	2.46	5.06	1.13	1.83	8.02	7.00	6.19	6.00	10.40	10.00	24 14	31 00
.08	2.05	6.18	1.86	1.74	9.78	9.00	8.04	8.00	2.99	3.00	18 15	26 00
.39	2.46	3.32	2.94	1.78	8.04	7.00	6.26	6.00	5.79	6.00	19 78	28 00
.90	0.82	4.00	2.29	2.68	8.97	8.00	6.29	7.00	1.27	1.00	11 41	21 00
.02	0.82	7.06	1.75	2.50	11.31	9.00	8.81	8.00	4.54	4.00	17 04	22 00
.36	3.28	4.76	1.85	2.34	8.95	7.00	6.61	6.00	10.02	10.00	27 01	33 00
.32	0.82	4.94	1.96	2.37	9.27	5.00	6.90	4.00	6.04	6.00	17 34	29 00
.81	3.28	6.54	1.57	1.96	10.07	9.00	8.11	8.00	6.76	7.00	23 77	34 00

...gely, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid a

MANUFACTURER AND BRAND.	WH
American Agricultural Chemical Co. (Cont.)	
Sharpless & Carpenter Branch.	
Soluble Tampico Guano	Fishin
Farmers' Improved Potato Manure	Medfor
Gilt Edge Potato and Tobacco Manure	Cedarv
No. 1 Bone Phosphate	"
Susquehanna Branch.	
Ammoniated Bone Phosphate	Hope..
Potato Phosphate	" ..
Tygert-Allen Branch.	
Ten Per Cent. Guano	Colling
Star Bone Phosphate	Cedarv
Peerless Potato Manure	Bridge
Fish, Bone and Potash	Pleasa
Special Brand Potato Manure	"
Howitz's Potato Fertilizer	Jackso
Star Guano	Bridge
Truckers' Triumph Potato Guano	Jackso
Nitro Phosphate	Mt. Ho
Wheeler Branch.	
Potato Manure	Sewell
Sweet Potato Manure	Swede
Corn Fertilizer	Cape M
Royal Wheat Grower	"
Williams & Clark Branch.	
High-Grade Special Fertilizer	Dayton
Royal Bone Phosphate	"
Americus Universal Ammoniated Dissolved Bone	River
Good Grower Potato Phosphate	Martin
Potato Phosphate	Rahwa
Prolific Fertilizer	Millsto
Americus Fertilizer	Dayton
Armour Fertilizer Works, Baltimore, Md.	
Bone, Blood and Potash	Cranbu
Grain Grower	Hacke
Wheat, Corn and Oat Special	Califor
Ammoniated Bone with Potash	Bound
Fruit and Root Crop Special	Hacke
High-Grade Potato	"

Complete Fertilizers

rnishing Nitrogen, Phosphoric Acid and Potash.

n.		Phosphoric Acid.							Potash.			
							Available.					
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.15	3.28	5.68	2.52	1.58	9.78	9.00	8.20	8.00	7.50	7.00	$25 60	$26 25
.23	3.28	4.70	2.28	0.91	7.84	7.00	6.93	6.00	10.04	10.00	26 34	28 00
.52	1.64	6.58	2.02	1.10	9.70	9.00	8.60	8.00	9.82	10.00	22 41	28 00
.73	1.64	4.46	3.09	1.76	9.31	9.00	7.56	8.00	1.90	2.00	15 58	22 00
.92	1.64	6.00	2.35	2.51	10.86	9.00	8.35	8.00	2.14	2.00	17 43	27 00
.48	1.64	6.70	1.89	1.82	10.41	9.00	8.59	8.00	5.54	5.00	18 91	28 00
.50	8.20	2.90	2.62	0 75	6.27	5.00	5.52	4.00	4.02	4.00	33 47	45 00
.01	2.05	5.58	2.77	1.40	9.75	9.00	8.35	8.00	3.03	3.00	18 12	23 00
.64	1.64	5.78	2.14	1.26	9.18	9.00	7.92	8.00	9.53	10.00	21 94	28 00
.36	2.46	4.32	3.71	2.64	10.67	11.00	8.03	9.00	2.17	2.00	18 71	28 00
.98	2.05	6.48	2.53	1.59	10.60	9.00	9.01	8.00	5.69	6.00	20 88	28 00
.28	1.23	2.34	3.42	1.66	7.42	7.00	5.76	6.00	5.00	5.00	14 89	23 00
.03	2.05	3.68	3.89	2.74	10.31	9.00	7.57	8.00	3.37	3.00	18 24	25 00
.27	3.28	2.28	3.76	1.65	7.69	7.00	6.04	6.00	9.63	10.00	25 68	32 00
.18	2.05	2.56	5.28	3.02	10.31	9.00	7.79	8.00	3.34	3.00	19 04	23 00
.10	2.05	5.88	2.08	1.72	9.68	9.00	7.96	8.00	3.15	3.00	18 26	25 00
.98	2.05	6.70	2.27	1.65	10.62	9.00	8.87	8.00	5.89	6.00	21 10	27 00
.67	1.64	5.16	2.61	2.13	9.90	9.00	7.77	8.00	2.06	2.00	15 88	26 00
.95	0.82	4.34	3.09	1.80	9.23	9.00	7.43	8.00	3.11	2.00	13 88	21 00
.45	3.28	5.86	2.81	1.62	10.29	9.00	8.67	8.00	7.44	7.00	26 82	32 00
.28	1.03	2.74	4.87	3.74	11.35	9.00	7.61	8.00	2.73	2.00	15 60	23 00
.80	1.64	4.94	3.24	3.55	11.73	9.00	8.18	8.00	2.14	2.00	17 36	24 00
.68	0.82	1.76	3.98	3.04	8.78	7.00	5.74	6.00	5.72	4.00	17 36	24 00
.63	2.46	2.98	3.04	2.09	8.11	7.00	6.02	6.00	6.66	6.00	20 96	32 00
.14	0.82	2.72	4.16	2.64	9.52	8.00	6.88	7.00	1.40	1.00	12 89	20 00
.73	2.46	5.40	3.62	3.00	12.02	11.00	9.02	9.00	2.28	2.00	21 11	28 00
.33	4.10	7.64	1.86	1.08	10.58	10.00	9.50	8.00	6.64	7.00	26 49	32 00
.57	1.64	6.98	1.20	0.99	9.17	10.00	8.18	8.00	2.56	2.00	15 94	25 00
.14	0.82	5.38	1.69	0.99	8.06	9.00	7.07	7.00	1.28	1.00	12 27	21 00
.64	2.46	5.36	1.52	0.91	7.79	8.00	6.88	6.00	2.16	2.00	17 79	25 00
.72	1.64	7.30	1.12	0.56	8.98	10.00	8.42	8.00	5.20	5.00	18 74	32 00
.71	1.64	7.00	2.16	1 02	10.18	10.00	9.16	8.00	*10.24	10.00	24 39	35 00

ely, if not entirely, in form of sulphate.

Complete Fertilizer

Furnishing Nitrogen, Phosphoric Aci

MANUFACTURER AND BRAND.	
Warren Atkinson, Mullica Hill, N. J.	
High-Grade Potato and Early Truck Fertilizer	Mu
Potato and General Truck	
Special Sweet Potato Fertilizer	
Cabbage and Tomato Manure	
Special Early Tomato Grower	
J. H. Baird, Marlboro, N. J.	
Potato Manure	Ma
Asparagus Manure	
Grass Manure	
Baugh & Sons' Co., Philadelphia, Pa.	
$25 Phosphate	We
Special Potato Manure	Mo
The Berg Co., Philadelphia, Pa.	
Lymph Guano for All Crops	Mo
$25 Special Bone Manure	Be
Standard Bone Manure	Ha
$35 Potato Manure	Co
Berger Bros., Easton, Pa.	
Potato and Truck	Ph
Peerless Phosphate	
Bowker Fertilizer Co., Boston, Mass.	
Stockbridge Potato and Vegetable Manure	Br
Stockbridge Top Dressing	Be
Stockbridge Corn Manure	Ri
Early Potato Manure	Se
Potato and Vegetable Fertilizer	Br
Farm and Garden Phosphate	Bl
Potash-Bone	Pa
Sweet Potato and Truck Manure	Sw
Bone and Wood-Ash Fertilizer	Re
Hill and Drill Phosphate	
Sure Crop Phosphate	Pit
Bone and Potash, Square Brand	Mi
Potash, or Staple Phosphate	Pe
Lawn and Garden Dressing	Pl
Fish and Potash, Square Brand	
Ammoniated Dissolved Bone	Mo
Corn Phosphate	Wh
Six Per Cent. Potato Fertilizer	Mo

Complete Fertilizers

rnishing Nitrogen, Phosphoric Acid and Potash.

.		Phosphoric Acid.							Potash.			
							Available.					
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.61	3.69	6.72	3.28	1.55	11.55	11.00	10.00	9.00	8.09	7.00	$29 18	$31 00
.88	2.46	6.28	1.35	1.98	9.61	10.00	7.63	7.00	6.94	7.00	26 75	27 00
.90	1.64	4.50	3.74	3.86	11.60	10.00	8.24	8.00	10.64	10.00	24 89	27 00
.62	2.46	4.66	3.66	3.46	11.78	9.00	8.32	7.00	6.40	5.00	23 59	26 00
.07	4.92	5.72	2.04	1.04	8.80	8.00	7.76	7.00	4.85	4.00	28 46	32 00
.71	3.28	4.70	4.28	2.12	11.10	10.00	8.98	8.00	8.52	10.00	28 99	31 00
.51	6.56	1.34	6.23	2.72	10.29	9.00	7.57	7.00	4.77	2.00	33 30	33 50
.14	8.20	1.70	4.32	1.32	7.34	....	6.02	4.00	5.07	5.00	35 73	37 00
.70	1.64	5.68	4.21	2.88	12.77	....	9.89	8.00	1.23	1.00	17 70	23 00
.78	1.64	4.10	2.22	1.68	8.00	....	6.32	5.00	9.90	10.00	21 28	27 00
.19	2.87	3.62	4.04	2.39	10.05	10.00	7.66	7.00	12.48	8.00	29 47	33 00
.32	1.64	5.30	4.52	3.17	12.99	....	9.82	7.00	2.56	2.00	19 28	25 00
.05	2.46	3.78	6.24	4.24	14.26	....	10.02	8.00	6.65	6.00	23 89	30 00
.51	2.46	3.40	6.36	3.20	12.96	....	9.76	7.00	10.53	10.00	28 11	33 75
.16	2.46	5.76	2.81	1.50	10.07	10.00	8.57	8.00	6.02	6.00	24 27	30 00
.19	0.82	2.96	5.06	1.90	9.92	10.00	8.02	8.00	2.45	2.00	14 79	20 00
.31	3.28	3.92	3.71	2.50	10.13	7.00	7.63	6.00	10.27	10.00	28 04	36 00
.33	4.92	3.88	3.04	1.83	8.75	6.00	6.92	5.00	6.31	6.00	28 34	35 00
.68	3.28	4.50	2.84	2.57	9.91	10.00	7.34	7.00	7.62	7.00	26 72	36 00
.28	3.28	5.64	2.51	2.01	10.16	8.00	8.15	7.00	6.86	7.00	25 24	33 00
.87	2.46	4.00	4.77	4.08	12.85	10.00	8.77	9.00	4.66	4.00	23 61	30 00
.72	1.64	4.60	3.75	3.21	11.56	11.00	8.35	9.00	2.04	2.00	16 91	25 00
.78	0.82	4.34	2.60	1.69	8.63	8.00	6.94	6.00	2.12	2.00	11 93	22 00
.69	1.64	3.42	5.04	3.00	11.46	8.00	8.46	6.00	7.74	8.00	21 64	27 00
.33	1.64	0.00	7.32	3.70	11.02	8.00	7.32	6.00	*1.88	2.00	16 33	28 00
.64	2.46	6.18	3.53	2.89	12.60	11.00	9.71	9.00	2.21	2.00	21 24	30 00
.03	0.82	2.76	4.70	2.97	10.43	11.00	7.46	9.00	2.23	2.00	13 88	21 00
.95	1.64	2.72	4.65	5.55	12.92	12.00	7.37	6.00	2.14	2.00	17 85	24 00
.03	0.82	0.78	6.10	3.95	10.83	10.00	6.88	8.00	2.91	3.00	14 24	23 00
.38	3.28	7.90	2.13	2.65	12.68	8.00	10.03	6.00	4.90	5.00	25 40	60 00
.40	2.46	2.08	3.18	3.81	9.07	8.00	5.26	....	4.08	4.00	18 17	33 00
.84	1.64	3.96	4.65	4.61	13.22	10.00	8.61	8.00	2.08	2.00	18 13	35 00
.77	1.64	3.50	4.75	5.27	13.52	10.00	8.25	8.00	2.09	2.00	17 86	26 00
.58	0.82	1.98	6.63	4.60	13.21	9.00	8.61	6.00	4.18	6.00	22 27	35 00

ely, if not entirely, in form of sulphate.

Complete Fertilize

Furnishing Nitrogen, Phosphoric Acid

MANUFACTURER AND BRAND.	
Bradley & Green Fertilizer Co., Philadelphia, Pa.	
Seven Per Cent. Ammonia Guano	Ma
Extra High-Grade Potato Guano	Fr
Wm. M. Brown, Cedarville, N. J.	
Special Potato Manure	Ce
C. C. Clark & Son, Mt. Ephraim, N. J.	
Truckers' Joy	Mt
E. Frank Coe Co., New York City.	
Famous Red Brand, Excelsior Guano	Fr
Alkaline Bone Phosphate	Sk
Peach Tree, Fruit and Grape Vine Fertilizer	Fr
Ammoniated Dissolved Bone Phosphate	Hi
Extra Special Potato Fertilizer	Ja
Ground Bone and Potash	Hi
XXV Ammoniated Bone Phosphate	Bo
Excelsior Guano	El
Famous American Lawn Fertilizer	Cl
J. S. Collins & Son, Moorestown, N. J.	
Fish Guano	Mo
Truck Guano	
High-Grade Fertilizer for Potatoes and General Use	
Cabbage and Tomato Fertilizer	
Collins & Pancoast, Merchantville, N. J.	
High-Grade Fertilizer for Potatoes and General Use	Me
Ten Per Cent. Guano	
Fish Guano	
Cabbage and Tomato Fertilizer	
Truck Guano	
A. A. Cortelyou, Neshanic Station, N. J.	
Special Fertilizer for Corn and Potatoes	Ne
Wheat and Rye Special	
Special Ammoniated Wheat and Rye	
Special for Corn, Wheat and Rye	
I. S. Curtis, Frenchtown, N. J.	
High Grade Bone Phosphate	Fr
Davis, Colson & Co., Woodstown, N. J.	
Our Bone Phosphate	Wo
Potato and Tomato Phosphate	

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

trogen.			Phosphoric Acid.							Potash.		Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
								Available.					
From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4.62	6.03	5.74	6.00	1.42	1.06	8.48	9.00	7.42	7.00	4.49	5.00	$31 31	$37 00
2.28	3.33	3.28	4.56	2.83	1.70	9.09	8.00	7.39	6.00	9.89	10.00	27 31	29 00
1.92	2.87	2.46	5.52	2.15	2.06	9.73	....	7.67	7.00	10.50	10.00	26 61	28 00
2.64	4.12	4.10	3.50	2.50	1.57	7.57	....	6.00	8.00	6.47	6.00	25 28	31 00
1.82	3.37	3.28	7.78	1.49	2.25	11.52	10.50	9.27	9.00	*6.17	6.00	27 47	34 00
1.36	1.36	1.23	8.30	1.53	2.73	12.56	10.00	9.83	8.50	*3.07	2.50	18 48	24 00
1.33	1.33	0.82	6.78	1.53	2.94	11.25	....	8.31	8.00	*5.19	5.00	19 07	28 00
1.53	1.53	1.23	6.14	2.01	3.84	11.99	10.00	8.15	8.00	*2.58	2.25	17 32	25 00
1.29	1.79	1.64	7.18	1.31	2.71	11.20	9.50	8.49	8.00	*9.30	10.00	24 78	28 00
1.63	1.63	1.64	0.00	5.85	11.82	17.67	14.00	5.85	....	2.15	2.00	17 79	28 00
1.30	1.30	0.82	8.26	1.43	3.45	13.14	10.00	9.69	8.50	2.29	1.50	17 31	23 50
2.17	3.05	3.28	8.06	1.21	2.60	11.87	10.00	9.27	9.00	*5.32	3.40	25 69	40 00
2.31	2.96	3.28	5.86	2.14	2.68	10.68	7.00	8.00	6.00	*4.43	4.00	23 07	38 00
1.80	2.36	2.46	6.10	2.01	1.21	9.32	....	8.11	8.00	3.65	4.00	19 48	26 00
1.46	1.68	1.64	5.16	2.96	1.32	9.44	....	8.12	8.00	2.00	2.00	15 90	23 00
1.67	2.48	2.46	4.32	4.09	1.53	9.94	....	8.41	8.00	*10.68	10.00	26 61	28 00
2.06	3.05	3.28	7.12	1.10	0.72	8.94	....	8.22	7.00	4.99	5.00	22 52	27 00
1.36	2.68	2.46	4.60	3.73	1.42	9.75	....	8.33	8.00	*10.52	10.00	26 88	28 00
3.94	7.88	8.20	2.76	2.16	0.87	5.79	....	4.92	4.00	4.48	4.00	34 82	45 00
1.87	2.36	2.46	6.52	1.88	1.25	9.65	....	8.40	8.00	3.87	4.00	19 99	26 00
2.31	3.41	3.28	6.76	1.12	0.68	8.56	....	7.88	7.00	4.97	5.00	23 30	27 00
1.56	1.79	1.64	5.26	2.70	1.47	9.43	....	7.96	8.00	1.98	2.00	16 15	23 00
2.12	2.74	3.28	1.52	5.07	3.48	10.07	12.00	6.59	....	4.40	8.00	20 77	30 00
1.77	1.77	1.64	7.10	0.91	0.84	8.85	....	8.01	8.00	2.15	2.00	16 02	21 00
1.79	1.79	1.64	4.86	3.22	2.83	10.91	....	8.08	8.00	2.51	2.00	17 25	20 00
0.54	0.76	1.64	0.00	8.25	2.70	10.95	....	8.25	8.00	2.81	2.00	14 23	22 00
1.21	1.72	1.64	3.28	3.29	3.04	9.61	....	6.57	8.00	3.30	3.00	16 12	25 00
2.58	3.34	2.87	6.50	2.08	0.82	9.40	9.00	8.58	8.00	*7.79	6.00	26 66	28 00
2.00	2.52	2.46	4.76	3.19	1.15	9.10	9.00	7.95	8.00	*7.13	5.00	22 97	24 00

n largely, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and P

MANUFACTURER AND BRAND.	WHERE
B. F. Demaris & Son, Cedarville, N. J.	
Special Superphosphate	Bridgeton
Fish Guano	"
Complete Bone Fertilizer	"
Truckers' Potato Manure	"
J. H. Denise, Freehold, N. J.	
High-Grade Fertilizer	Howell Stati
Complete Potato Manure	Freehold
Excelsior Potato Manure	Cranbury
H. W. Doughten, Moorestown, N. J.	
Sure Shot Superphosphate	Moorestown
Special Potato Manure	"
Dried and Ground Fish Guano	"
J. G. Downward & Co., Coatesville, Pa.	
Royal Bone Phosphate	Ringoes
Special Bone Fertilizer	"
Frank Emmons, Newton, N. J.	
Special Potato Manure	Andover
J. C. Fifield & Sons Co., Bakersville, N. J.	
Special Potato and Cabbage Manure	Woodbury
Special Sweet Potato Manure	"
Fithian & Pennell, Bridgeton, N. J.	
Complete Phosphate	Bridgeton
W. O. Garrison, Bridgeton, N. J.	
Bay Side Fertilizer	Bridgeton
Murphy Brands for Potatoes and Tomatoes	"
Truckers' Pride	Erma
Our Pride Fish Guano	"
Gold Dust	Bridgeton
Farmers' Pride	"
Pride of Cumberland	"
J. C. Griscom, Woodbury, N. J.	
King Crab Compound	Woodbury
Wyckoff Hendrickson, Allentown, N. J.	
Wheat and Rye Manure	Allentown
High-Grade Potato Manure	Hamilton Sq
Corn and Truck Manure	Allentown
Special Potato Manure	Robbinsville

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

	itrogen.			Phosphoric Acid.							Potash.			
									Available.					
	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
..	0.82	0.82	0.82	6.96	2.40	1.02	10.38	10.00	9.36	....	1.54	1.00	$13 79	$19 00
..	2.04	2.04	2.46	6.32	2.41	1.43	10.16	9.00	8.73	....	2.34	2.50	18 02	23 00
..	1.09	1.75	1.64	6.20	4.41	4.39	15.00	15.00	10.61	....	1.79	2.50	19 47	23 00
..	1.35	2.56	3.28	6.94	2.62	1.46	11.02	....	9.56	9.00	4.60	7.50	22 14	28 00
..	2.64	4.42	4.10	3.96	4.19	1.59	9.74	8.00	8.15	....	8.01	8.00	29 65	29 00
..	2.05	3.75	3.49	5.80	3.25	1.50	10.05	9.00	8.55	....	9.32	10.00	28 94	29 00
.	2.72	4.34	4.31	3.88	4.31	2.07	10.26	9.25	8.19	....	8.74	8.75	30 29	32 00
..	2.36	2.36	2.46	9.04	1.85	2.33	13.22	11.00	10.89	10 00	3.90	3.00	22 93	27 00
4	1.04	2.78	2.46	8.70	1.36	1.54	11.60	....	10.06	10 00	7.23	7.00	26 00	29 00
..	3.65	3.65	3.69	1.74	1.74	3.53	7.01	5.85	3.48	....	3.91	3.00	20 26	28 00
..	0.87	0.87	0.82	3.32	4.34	2.04	9.70	9.00	7.66	8.00	2.67	2.00	13 62	23 00
..	1.11	1.11	1.23	2.80	4.45	2.01	9.26	10.00	7.25	7.00	2.75	2.50	14 07	25 00
..	2.18	3.33	3.28	5.02	3.16	1.92	10.10	....	8.18	7.00	9.49	9.00	27 66	33 00
..	2.52	2.52	2.46	3.62	4.14	1.60	9.36	....	7.76	7.00	7.74	7.00	23 30	35 00
..	2.25	2.25	2.05	2.30	4.74	1.47	8.51	....	7.04	5.00	9.82	10.00	23 41	35 00
..	1.33	1.70	1.64	4.46	4.13	4.49	13.08	10.00	8.59	8.00	2.13	2.00	17 70	22 50
..	1.16	1.70	2.05	5.32	3.75	1.18	10.20	8.50	9.07	7.50	2.60	2.50	17 18	22 50
7	1.45	2.52	2.46	5.44	3.00	1.28	9.67	....	8.44	8.00	9.43	10.00	25 27	30 00
..	1.31	2.96	3.28	4.94	3.18	1.05	9.17	....	8.12	8.00	5.08	7.00	22 13	33 00
..	1.55	2.36	4.10	3.64	4.49	1.59	9.72	... .	8.13	8.00	5.75	8.00	21 21	32 00
..	0.92	0.92	0.82	5.24	3.78	1.34	10.36	....	9.02	9.00	2.03	2.00	14 33	17 00
..	1.88	1.88	1.64	5.24	2.66	1.53	9.43	....	7.90	8.00	3.11	3.00	17 36	25 00
..	1.85	1.85	1.64	4.74	3.58	1.12	9.44	....	8.32	8.00	1.90	2.00	16 50	25 00
9	2.17	3.81	4.10	5.28	3.56	1.18	10.02	10.00	8.84	8.00	5.61	5.00	26 46	31 00
..	2.25	2.25	0.82	7.34	3.61	3.14	14.09	12.00	10.95	10.00	3.14	2.00	22 31	20 00
..	2.84	3.97	3.28	4.78	3.22	1.59	9.59	....	8.00	9.00	9.88	10.00	29 80	32 00
.	2.27	2.27	1.64	7.16	3.65	2.88	13.19	11.00	10.81	9.00	4.32	4.00	22 92	27 00
..	2.34	3.35	2.46	6.12	2.50	1.09	9.71	10.00	8.62	8.00	9.85	10.00	28 18	32 00

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and I

MANUFACTURER AND BRAND.	WHERE
S. M. Hess & Bro., Philadelphia, Pa.	
Potato and Truck Manure	Ringoes
Fish and Potash	Toms River
Special Potato Manure	Cranbury
Special Cabbage Manure	Ringoes
Wheat and Grass Manure	German Val
G. C. Higgins & Son, Three Bridges, N. J.	
Golden Rod	Three Bridg
Ira Hill, Copper Hill, N. J.	
Potato Fertilizer	Copper Hill
Pure Bone Phosphate	" "
Hill & Co., Flemington, N. J.	
Ten Per Cent. Potato Fertilizer	Flemington
No. 2	"
Standard Fertilizer	"
Hires & Co., Quinton, N. J.	
Special Potato and Tomato Phosphate	Quinton
Standard Bone Superphosphate	"
W. B. Hitchner, Woodstown, N. J.	
High-Grade Potato Manure	Woodstown
The Hubbard Fertilizer Co., Baltimore, Md.	
Standard Bone Superphosphate	Gloucester
Royal Ensign for Early Market Vegetables	"
Farmers' IXL Superphosphate	"
Truckers' Seven Per Cent. Royal Seal Compound	"
International Seed Co., Rochester, N. Y.	
Potato and Truck Manure	Cranbury
A1 Special Manure	"
Grain and Grass Fertilizer	Afton
Hervey Kuhl, Flemington, N. J.	
Complete Fertilizer	Flemington
Bone and Potash	"
Lackawanna Fertilizer and Chemical Co., Moosic, Pa.	
Kali Chief	Erma
Moosic Phosphate	Stillwater
Bone Superphosphate	Baptistown
Admiral Dewey	Pattenburg
Special Manure	Blairstown
Samuel Lederer & Sons, New Brunswick, N. J.	
Potato Fertilizer	South Bound

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

...ogen.			Phosphoric Acid.							Potash.			
...From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.25	2.21	2.46	4.18	4.36	1.86	10.40	....	8.54	8.00	5.09	6.00	$20 90	$29 00
.28	2.28	2.05	5.42	2.88	2.31	10.61	....	8.30	8.00	3.57	3.00	19 78	30 00
.74	2.97	3.28	7.02	1.92	1.67	10.61	....	8.94	8.00	6.79	7.00	25 C3	30 00
.66	2.71	3.28	3.48	3.14	2.09	8.71	....	6.62	6.00	4.05	4.00	19 85	30 00
.03	1.03	0.82	5.36	2.35	2.79	10.50	9.00	7.71	8.00	2.57	2.00	14 42	22 00
.16	1.16	1.23	6.42	1.88	1.92	10.22	....	8.30	8.00	4.18	4.00	16 45	21 00
.51	2.51	2.46	1.80	6.76	1.54	10.10	....	8.56	10.50	9.04	9.00	25 14	29 00
.17	2.17	2.05	2.02	6.61	1.82	10.45	....	8.63	10.50	3.55	2.50	19 54	24 00
.80	1.80	1.64	4.24	3.48	1.50	9.22	9.00	7.72	8.00	10.75	10.00	23 40	27 00
.08	1.08	0.82	3.76	3.85	2.68	10.29	9.00	7.61	8.00	2.25	2.00	14 15	20 00
.22	2.22	2.05	3.80	3.22	2.64	9.66	8.00	7.02	7.00	2.83	2.50	17 82	23 00
.85	2.43	2.46	6.32	1.59	2.65	10.56	10.00	7.91	8.00	4.71	5.00	20 88	24 00
.17	1.80	1.64	5.56	2.31	2.56	10.43	9.50	7.87	8.00	3.29	3.00	17 50	21 00
.20	2.20	2.46	5.80	1.82	1.87	9.49	....	7.62	7.00	8.38	8.00	22 75	23 00
.00	1.86	1.64	5.62	2.49	2.38	10.49	....	8.11	8.00	2.91	3.00	17 41	25 00
.17	2.11	2.46	6.36	2.58	2.73	11.67	....	8.94	8.00	4.52	4.00	20 55	28 00
.13	2.05	1.64	4.46	3.16	2.90	10.52	....	7.62	8.00	2.44	2.00	17 34	23 00
.08	5.24	5.74	5.40	1.57	0.92	7.89	....	6.97	6.00	5.23	5.00	28 73	35 00
.50	1.50	1.23	4.82	3.75	2.34	10.91	9.00	8.57	8.00	7.05	7.00	20 45	27 00
.76	2.23	2.46	2.20	4.51	1.76	8.47	7.00	6.71	6.00	10.39	10.00	23 44	33 00
.79	1.79	1.64	7.44	2.90	2.54	12.88	11.00	10.34	10.00	2.36	2.00	19 28	25 00
.15	2.71	2.46	6.06	4.36	3.64	14.06	....	10.42	12.00	1.90	2.00	22 28	28 00
.95	0.95	0.82	6.40	3.97	2.60	12.97	10.00	10.37	8.00	1.13	1.00	15 51	20 00
.28	1.28	0.82	4.04	1.88	1.82	7.74	9.00	5.92	7.00	7.91	8.00	17 59	32 00
.42	1.42	1.23	6.50	2.66	1.10	10.26	9.00	9.16	7.00	2.83	1.50	16 70	25 00
.36	1.36	1.64	8.32	2.54	1.29	12.15	12.00	10.86	10.00	2.55	2.00	18 04	24 00
.34	1.34	0.82	3.56	3.45	3.20	10.21	7.00	7.01	6.00	1.21	1.00	13 74	20 00
.35	2.35	2.46	6.92	2.91	1.62	11.45	12.00	9.83	10.00	5.59	6.50	22 99	32 00
.03	3.92	3.28	0.20	7.40	4.56	12.16	12.00	7.60	....	1.71	8.00	23 55	30 00

Complete Fertilizer

Furnishing Nitrogen, Phosphoric Acid

MANUFACTURER AND BRAND.	V
Lister's Agricultural Chemical Works, Newark, N. J.	
Special Ten Per Cent. Potato	Ma
Standard Pure Bone Superphosphate	Rec
Potato Manure	Ver
Mount Rose Corn Fertilizer	Per
Ammoniated Dissolved Bone Phosphate	Ski
U. S. Superphosphate	Ma
"G" Brand	Leb
Success Fertilizer	Pit
Potato and Corn Fertilizer, No. 2	Ma
Special Corn and Potato Fertilizer	Mic
Special Crop Producer Fertilizer	
Harvest Queen Phosphate	Ger
3-6-10 for Potatoes	Ma
3-6-10 for Potatoes	Bo
The Mapes Formula & Peruvian Guano Co., N.Y. City.	
Potato Manure	Car
Cauliflower and Cabbage Manure	Nev
Corn Manure	Ma
Fruit and Vine Manure	Ha
Top Dresser—Half Strength	
Top Dresser—Full Strength	Ma
Complete Manure for Light Soils	
Complete Manure for Heavy Soils	
Complete Manure for Average Soils	
Complete Manure, "A" Brand	Riv
General Crop Brand	Pit
Complete Manure, 10 per cent. Potash	Sto
Grain Brand	
Ammoniated Dissolved Bone with Potash	Pit
Cereal Brand	Cli
Lawn Top Dressing	Nev
Complete Manure for General Use	Mo
Grass and Grain Spring Top Dressing	Mo
John E. Minch, Bridgeton, N. J.	
Sweet Potato Manure	Bri
Complete Phosphate	
Mitchell Fertilizer Co., Tremley, N. J.	
Special Vegetable Fertilizer	Ma

Complete Fertilizers

rnishing Nitrogen, Phosphoric Acid and Potash.

.		Phosphoric Acid.					Available.		Potash.			
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.77	1.64	7.48	1.20	1.18	9.86	....	8.68	8.00	*9.35	10.00	$24 34	$28 00
.98	2.46	9.10	1.52	2.00	12.62	11.00	10.62	9.00	2.49	2.00	20 06	28 00
.91	3.28	7.82	1.77	1.69	10.78	9.00	9.09	8.00	7.21	7.00	25 51	34 00
.12	1.64	6.88	1.62	2.11	10.61	10.00	8.50	8.00	1.87	1.00	17 93	23 00
.67	2.05	7.22	2.38	2.10	11.70	9.00	9.60	8.00	2.54	1.50	18 11	23 00
.34	1.03	7.80	0.97	1.86	10.63	10.00	8.77	8.00	*2.28	2.00	16 03	24 00
.38	0.82	6.94	1.56	1.67	10.17	10.00	8.50	8.00	2.68	4.00	16 00	22 00
.33	1.23	8.80	1.25	1.89	11.44	11.00	9.55	9.00	*2.31	2.00	16 82	22 00
.86	1.64	8.58	1.74	2.56	12.88	....	10.32	10.00	*3.96	4.00	21 09	27 00
.77	1.64	7.56	1.08	1.53	10.12	9.00	8.59	8.00	2.97	3.00	17 57	24 00
.06	0.82	6.60	0.93	1.28	8.76	8.00	7.53	7.00	*1.41	1.00	12 93	20 00
.37	1.23	7.08	2.80	3.88	13.26	11.00	9.38	9.00	*1.81	2.00	17 26	20 00
.76	2.46	7.56	1.30	2.12	10.98	....	8.86	6.00	5.40	10.00	23 41	33 00
.33	2.46	5.88	1.55	0.87	8.30	....	7.43	6.00	*8.93	10.00	24 23	30 00
.01	3.69	2.96	5.14	2.13	10.23	8.00	8.10	8.00	*7.03	6.00	28 50	36 50
.23	4.10	2.46	5.21	1.45	9.12	6.00	7.67	6.00	7.29	6.00	27 61	36 00
.74	2.46	2.00	6.33	2.60	10.93	10.00	8.33	8.00	6.06	6.00	23 34	35 00
.24	1.64	2.42	3.96	2.05	8.43	7.00	6.38	5.00	*10.95	10.00	24 91	41 00
.92	4.92	0.62	2.30	1.30	4.22	4.00	2.92	....	*2.16	2.00	20 47	33 00
.93	9.84	1.46	4.81	3.10	9.37	8.00	6.27	....	*4.50	4.00	39 12	50 00
.19	4.92	2.06	4.47	2.41	8.94	8.00	6.53	6.00	*7.46	6.00	30 90	40 00
.94	4.92	2.54	5.25	2.71	10.50	10.00	7.79	8.00	*3.68	3.00	28 08	39 00
.53	4.10	2.62	4.87	1.80	8.79	8.00	6.99	7.00	*5.77	5.00	27 75	36 00
.90	2.46	8.18	7.87	2.96	13.51	12.00	10.55	10.00	3.38	2.50	23 67	35 00
.81	1.64	2.72	5.31	2.46	10.49	10.00	8.03	8.00	2.50	2.00	17 11	24 00
.35	2.03	1.04	3.90	1.44	6.38	5.00	4.94	3.00	10.40	10.00	21 99	30 00
.12	0.82	2.54	5.12	1.78	9.44	....	7.66	8.00	4.27	4.00	15 72	23 00
.45	1.23	5.50	6.05	1.87	13.42	12.00	11.55	10.00	2.08	1.50	18 85	28 00
.94	1.64	2.20	5.14	1.70	9.04	8.00	7.34	6.00	3.17	3.00	16 94	29 00
.50	2.46	0.44	3.28	1.33	5.05	3.50	3.72	....	3.54	2.50	14 92	35 00
.52	3.28	1.74	6.37	2.43	10.54	10.00	8.11	8.00	4.83	4.00	24 49	35 00
.10	4.92	1.92	5.48	1.83	9.23	6.00	7.40	5.00	7.30	7.00	30 35	41 00
.48	1.64	4.90	1.87	2.59	9.36	....	6.77	9.00	12.32	10.00	23 16	30 00
.44	2.05	7.68	1.65	2.62	11.95	....	9.33	9.00	4.38	4.00	21 76	24 00
.20	3.49	6.08	4.65	1.78	12.51	10.00	10.73	8.00	6.83	6.00	27 61	38 00

gely, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid

MANUFACTURER AND BRAND.	WI
Mixner and Mickel, Bridgeton, N. J.	
Phosphate for Oats	Bridg
High-Grade for Potatoes and Sweet Potatoes	"
Top Dresser for Strawberries and Asparagus	"
Special for Wheat, Oats and Peas	"
Fish Mixture for Tomatoes and Sweet Potatoes	"
Complete for Corn, Wheat, Potatoes and Tomatoes	"
Monmouth Fertilizer Works, Shrewsbury, N. J.	
Special Potato Manure	Shrew
Albert Nelson and Co., Allentown, N. J.	
Corn and Truck Fertilizer	Cranb
Potato Fertilizer	"
Special Potato Manure	Wind
Complete Potato and Truck	Allen
High-Grade Superphosphate	Hami
"A" Brand, Special Potato	"
Complete Potato Manure	Wind
Willetts' Brand, Special Potato Manure	Cranb
New Jersey Agricultural Chem. Co., Newark, N. J.	
Russell's Special Potato Fertilizer	Penn
Russell's Ammoniated Dissolved Bone Phosphate	Rock
Russell's Two Tons in One	Hope
Russell's Ten Per Cent. Potato Fertilizer	Flem
Russell's Champion Manure	Hope
Russell's Special Corn Manure	Rock
Russell's Potato Manure	Some
Newport Fertilizer Co., Philadelphia, Pa.	
No. 1 Bone Phosphate	Cold
Fish, Bone and Potash	Cranl
Gilt Edge Potato and Tobacco Manure	Stock
Gilt Edge Potato and Tobacco Manure	Berge
Truckers' Joy	Bridg
Truckers' Joy	Mata
Evans Brand	Benn
Rectified Phosphate	Mata
Potato, Tobacco and Truck Guano	Penn
Grain and Grass Special	Colur
Farmers' Ammoniated Bone Phosphate	Hight
Special Compound	Jobst
Clark's High Grade	Mt. E
Clark's Special	"

Complete Fertilizers

urnishing Nitrogen, Phosphoric Acid and Potash.

en.		Phosphoric Acid.							Potash.			
							Available.					
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.32	0.82	4.00	3.50	2.88	10.38	....	7.50	8.00	2.45	2.00	$14 97	$18 00
.32	2.46	4.20	2.43	2.15	8.78	....	6.63	6.00	*9.86	10.00	23 94	30 00
.77	4.51	5.64	1.87	2.89	10.40	....	7.51	6.00	7.06	10.00	23 63	33 00
.75	1.64	5.54	2.16	2.54	10.24	....	7.70	8 00	3.60	3.00	17 34	22 00
.60	2.46	4.64	1.85	2.19	8.68	....	6.49	7.00	4.33	3.50	19 57	25 00
.52	2.46	6.50	1.38	2.62	10.50	....	7.88	8.00	5.25	5.00	21 31	25 00
.35	2.46	1.52	2.44	1.33	5.29	....	3.96	6.00	7.60	8.00	18 71	31 00
.64	2.46	5.20	5.05	2.56	12.81	10.00	10.25	8.00	4.84	4.00	23 76	25 00
.21	3.28	4.44	3.18	1.31	8.93	....	7.62	6.00	9.89	10.00	29 80	30 00
.74	1.64	5.28	4.51	2.57	12.36	....	9.79	8.00	10.60	10.00	25 38	27 00
.87	1.64	6.42	2.87	2.14	11.43	....	9.29	9.00	10.22	10.00	24 78	28 00
.59	1.64	3.18	5.84	4.18	13.20	10.00	9.02	8.00	3.41	3.00	18 70	25 00
.74	2.46	4.58	4.83	2.09	11.00	....	8.91	6.00	10.29	10.00	27 19	28 00
.62	2.46	4.02	3.21	1.80	9.03	....	7.23	6.00	6.39	6.00	21 81	27 00
.88	3.28	7.78	0.68	0.14	8.60	....	8.46	6.00	10.00	10.00	29 29	34 00
.51	1.64	4.40	5.21	6.14	15.75	9.00	9.61	8.00	3.58	3.00	20 09	24 00
.84	1.89	4.40	4.99	6.73	16.12	11.00	9.39	9.00	2.82	1.50	20 55	24 00
.19	2.05	1.78	9.06	6.96	17.80	20.00	10.84	....	2.58	2.50	23 04	31 00
.68	1.64	4.60	3.88	4.60	13.08	9.00	8.48	8.00	9.65	10.00	24 06	27 00
.73	0.82	3.56	5.40	6.59	15.55	9.00	8.96	8.00	1.90	2.00	15 63	21 00
.77	1.64	4.30	4.79	7.22	16.31	9.00	9.09	8.00	2.92	3.00	20 30	24 00
.63	3.69	2.86	4.62	3.92	11.40	8.50	7.48	7.50	5.73	7.00	25 90	26 00
.44	1.64	4.66	3.20	2.49	10.35	9.00	7.86	8.00	2.17	2.00	15 46	25 00
.54	1.64	5.62	2.03	4.06	11.71	8.00	7.65	7.00	5.59	5.00	19 10	28 00
.50	1.64	6.86	1.66	2.06	10.58	9.00	8.52	8.00	8.18	10.00	21 24	28 00
.99	1.64	4.24	2.60	3.80	10.64	9.00	6.84	8.00	8.85	10.00	22 46	33 00
.50	4.10	4.24	2.58	2.96	9.78	9.00	6.82	8.00	4.48	6.00	23 03	35 00
.86	4.10	2.76	3.18	1.83	7.77	9.00	5.94	8.00	6.09	6.00	24 21	38 00
.18	3.28	4.82	1.86	2.20	8.88	8.00	6.68	7.00	10.68	10.00	26 75	32 00
.01	3.28	3.76	2.70	2.34	8.80	8.00	6.46	7.00	4.97	5.00	21 14	35 00
.81	0.82	3.28	2.63	1.92	7.83	7.00	5.91	6.00	6.01	6.00	14 38	28 00
.98	0.41	2.48	3.28	3.12	8.78	9.00	5.66	8.00	1.55	2.00	11 46	29 00
.70	0.82	2.88	3.58	2.99	9.45	8.00	6.46	7.00	2.71	4.00	12 27	24 00
.08	0.82	5.56	1.98	4.27	11.81	11.00	7.54	10.00	2.14	2.00	14 63	22 00
.08	3.23	3.92	2.38	2.17	8.47	....	6.30	8.00	6.70	7.00	22 48	30 00
.77	1.64	5.28	2.20	2.04	9.52	....	7.48	8.00	5.12	5.00	18 34	28 00

gely, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid a

MANUFACTURER AND BRAND.	WI
James E. Otis, Tuckerton, N. J.	
Special for Potatoes	Jacks
Menhaden Fish Guano	Moun
S. L. Pancoast, Mullica Hill, N. J.	
Early Potato Grower	Mulli
Early Truck Fertilizer	"
Peterson & Smith, Woodstown, N. J.	
Wheat and Oats Superphosphate	Wood
High-Grade Potato Fertilizer	"
Potato Superphosphate	"
R. H. Pollock, Baltimore, Md.	
Ammoniated Bone Phosphate	Milfo
Special Wheat Grower	"
Owl Brand Guano	"
Quaker City Pondrette Co., Philadelphia, Pa.	
Quaker City Pondrette	Moun
John Repp, Glassboro, N. J.	
High-Grade Fertilizer	Glass
Enos Richmond, Elmer, N. J.	
Special Potato Phosphate	Hain
Special Corn Manure	"
Edward Rigg, Jr., Burlington, N. J.	
Potato Manure	Burli
Fish Guano	"
M. F. Riley, Elmer, N. J.	
Potato Fertilizer	Elme
High-Grade Potato	"
Ruckman Bros., New Brunswick, N. J.	
Corn Fertilizor	New
C. W. Saul, Rio Grande, N. J.	
Anti-Trust Potato and Tomato Guano	Rio G
Sharpless & Bro., Camden, N. J.	
Ten Per Cent. Truck Guano	Camd
Extra High-Grade Potato Manure	"
Seven Per Cent. Guano	"
No. 1 for General Use	"

Complete Fertilizers

rnishing Nitrogen, Phosphoric Acid and Potash.

.		Phosphoric Acid.							Potash.			
							Available.					
Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.67	1.64	3.06	4.27	1.96	9.29	8.00	7.33	....	*4.81	10.00	$21 73	$29 00
.32	3.28	3.40	4.52	1.97	9.89	7.00	7.92	....	*2.58	5.00	22 25	28 00
.22	3.28	5.32	2.87	1.55	9.74	....	8.19	7.00	7.70	7.50	25 76	28 00
.86	2.67	6.24	2.74	1.86	10.84	....	8.98	8.00	5.04	5.00	23 31	25 00
.96	0.82	5.10	3.96	2.12	11.18	....	9.06	8.00	1.96	2.00	14 75	17 00
.10	3.28	3.98	3.72	1.78	9.48	....	7.70	8.00	8.29	8.00	25 37	28 00
.08	1.64	3.00	4.26	1.84	9.10	....	7.26	6.00	10.03	10.00	23 23	27 00
.77	1.64	4.40	3.69	1.23	9.32	9.00	8.09	8.00	2.37	2.00	16 44	23 00
.95	0.82	6.12	2.58	2.62	11.32	10.00	8.70	9.00	2.16	2.00	14 73	21 50
.63	0.41	3.90	3.25	2.28	9.38	8.00	7.15	7.00	1.56	1.50	11 45	19 50
.32	1.64	0.48	2.92	0.22	3.62	4.00	3.40	....	0.27	1.00	8 02	16 60
.06	2.05	4.50	3.76	2.30	10.56	10.00	8.26	8.00	10.45	10.00	24 86	26 00
.89	1.64	6.72	1.64	1.97	10.33	9.00	8.36	8.00	9.90	10.00	23 81	27 50
.90	0.82	7.10	2.33	2.26	11.69	....	9.43	9.00	3.71	3.00	16 45	19 50
.62	1.64	6.34	2.13	1.04	9.51	....	8.47	8.00	9.28	10.00	22 13	27 00
.38	2.46	4.58	2.77	1.07	8.42	....	7.35	7.00	5.22	5.00	20 08	26 00
.83	1.64	4.06	3.83	1.47	9.36	....	7.89	8.00	7.57	7.00	20 83	25 00
.73	2.46	4.28	3.66	1.40	9.34	....	7.94	7.00	9.14	8.00	24 97	25 00
.88	3.00	2.24	5.22	4.14	11.60	8.00	7.46	5.00	3.47	3.00	24 87	25 00
.48	2.46	3.84	3.31	1.60	8.75	....	7.15	7.00	8.11	7.00	22 66	27 00
7.51	8.20	1.26	3.30	1.80	6.36	....	4.56	4.00	4.67	4.00	33 32	45 00
.17	3.28	4.08	1.91	2.72	8.71	....	5.99	7.00	9.84	10.00	25 52	32 00
.14	5.74	3.82	1.89	1.90	7.11	....	5.21	5.00	10.00	9.00	30 69	38 00
.59	1.64	5.20	1.85	3.47	10.52	....	7.05	3.00	2.43	2.00	18 69	24 00

gely, if not entirely, in form of sulphate.

Complete Fertilize

Furnishing Nitrogen, Phosphoric Ac

MANUFACTURER AND BRAND.
M. L. Shoemaker & Co., Philadelphia, Pa.
Swift-Sure 10 Per Cent. Potato Special, No. 1
Swift-Sure Superphosphate for Potatoes
Swift-Sure Guano for Fall Trade
Swift-Sure Guano for Tomatoes, Truck and Corn
Swift-Sure Superphosphate for General Use
Swift-Sure New Jersey Special for Oats
$23-Phosphate
Good Enough Superphosphate
Muzzy Bros. Special
Lester Shurts, Neshanic Station, N. J.
Standard Bone Phosphate
L. W. Sickler, Glassboro, N. J.
Special 10 Per Cent. Potato Fertilizer
Guano for Tomatoes, Truck and Corn
Jos. Smith & Co., Stockton, N. J.
Oats Fertilizer
Special Potato Fertilizer
Special Fertilizer
Standard Fertilizer
Prallsville Formula
Rufus W. Smith, Elmer, N. J.
Banner Truck Manure
Complete Bone Fertilizer
Ammoniated Consummate Fertilizer
High-Grade Trucker Fertilizer
Somerset Chemical Co., Bound Brook, N. J.
5-8-7 Fertilizer
Cereal Bone Phosphate
Harvest Queen Phosphate
8-8-4 Fertilizer
Henry Taylor, Vineland, N. J.
$25-Potato Manure
Farm and Garden
Special Potato Fertilizer, No. 1
Special Potato Manure, No. 2

Complete Fertilizers

-rnishing Nitrogen, Phosphoric Acid and Potash.

		Phosphoric Acid.							Potash.			
							Available.					
	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
41	3.28	4.94	2.79	2.07	9.80	....	7.73	6.00	11.04	10.00	$28 81	$27 00
57	2.46	6.56	3.83	4.30	14.69	11.00	10.39	8.00	7.44	6.50	26 65	32 00
39	1.64	4.22	4.69	4.46	13.37	....	8.91	8.00	5.92	5.00	21 74	25 00
03	1.64	5.40	4.25	4.12	13.77	....	9.65	8.00	5.36	5.00	22 32	27 50
73	2.46	7.12	3.25	4.35	14.72	14.00	10.37	9.00	5.25	4.00	25 26	32 00
31	0.82	4.92	4.95	5.61	15.48	....	9.87	8.00	2.09	2.00	18 21	24 00
26	0.82	1.40	6.50	6.69	14.59	8.00	7.90	6.00	1.95	1.00	16 40	20 00
07	1.64	6.34	4.15	4.51	15.00	12.00	10.49	8.00	2.53	2.00	21 11	27 00
55	2.46	7.76	3.28	4.35	15.39	....	11.04	10.00	5.30	4.00	25 41	28 00
48	0.82	5.60	2.75	1.72	10.07	9.00	8.35	8.00	4.71	4.00	17 92	21 00
25	2.05	4.94	5.05	3.59	13.58	....	9.99	8.00	10.66	10.00	27 71	35 00
28	1.64	5.62	4.50	3.50	13.62	....	10.12	8.00	5.65	5.00	23 62	28 00
58	0.82	3.34	3.92	2.53	9.79	8.00	7.26	7.00	1.42	1.00	14 03	16 50
60	2.46	3.50	3.99	1.84	9.33	7.00	7.49	6.00	10.83	10.00	26 02	29 00
20	0.82	5.42	2.98	2.02	10.42	9.00	8.40	8.00	2.40	2.00	15 21	18 00
52	0.82	4.70	3.60	2.19	10.49	9.00	8.30	8.00	4.28	4.00	17 18	20 00
59	2.05	3.18	4.66	2.50	10.34	9.00	7.84	8.00	6.26	6.00	22 71	25 00
44	3.28	4.18	3.31	1.47	8.96	9.00	7.49	7.00	*7.56	8.00	26 79	27 00
36	2.05	5.76	2.58	1.15	9.49	10.00	8.34	8.00	4.28	3.00	20 23	20 00
19	0.82	6.84	2.31	1.00	9.65	10.00	8.65	9.00	2.56	3.00	15 16	17 00
69	2.46	5.22	2.23	1.66	9.11	9.00	7.45	7.00	*8.35	8.00	25 34	26 00
82	4.10	....	9.71	8.40	18.11	....	9.71	8.00	6.07	7.00	27 35	26 00
38	1.64	....	10.94	7.76	18.70	....	10.94	8.00	1.61	5.00	19 97	30 00
72	0.82	....	11.30	3.13	14.43	....	11.30	10.00	4.26	4.00	18 55	25 00
81	2.46	....	8.73	1.57	10.30	....	8.73	8.00	4.74	4.00	19 19	23 00
50	1.23	4.44	2.33	1.01	7.78	....	6.77	6.00	5.06	5.00	16 42	25 00
01	1.85	2.20	2.92	1.39	6.51	....	5.12	5.00	1.45	1.00	13 44	23 00
88	1.64	4.10	4.46	2.76	11.32	....	8.56	8.00	10.05	10.00	24 24	27 00
82	1.64	6.40	2.24	1.01	9.65	....	8.64	8.00	9.72	10.00	23 30	27 00

-ly, if not entirely, in form of sulphate.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid

MANUFACTURER AND BRAND.	W
Taylor Bros., Camden, N. J.	
High-Grade Potato Phosphate	Cam
Animal Bone Phosphate	"
The Taylor Provision Co., Trenton, N. J.	
Special Potato Fertilizer	Ceda
High-Grade Corn and Truck Manure	Ham
High-Grade Potato and Truck Fertilizer	Cran
A. D. B. Special Fertilizer	Lam
Ammoniated Dissolved Bone and Potash	
Bone, Tankage and Potash	Mills
I. P. Thomas & Son Co., Philadelphia, Pa.	
High-Grade Potato Manure	Moo
Cabbage Manure	
Special Sweet Potato Manure	Davi
Special Potato Manure	Moo
Potato Fertilizer	Salen
Vegetable Manure	"
Special High-Grade Potato Manure	Davi
Farmers' Choice Bone Phosphate	Robb
Potash and Improved	Flem
Wheat and Grass Compound	Titus
Improved Superphosphate	"
Grain Manure	"
Normal Bone Phosphate	"
Special Fish Mixture	Beve
Trenton Bone Fertilizer Co., Trenton, N. J.	
Excelsior	Elme
High Grade Potato Fertilizer	Cran
Special Potato Manure	Princ
Corn Mixture	Plain
$32 Potato Manure	Robb
Superphosphate	
Potato Manure	Ring
Bergen Special for Spring	Ewin
Grain Manure	Midd
Stults' Special for Wheat and Grass	
XX Brand Fertilizer	

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash

ogen.			Phosphoric Acid.							Potash.			
								Available.					
From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
07	2.07	1.64	4.38	2.14	1.29	7.81	....	6.52	5.00	10.67	10.00	$22 94	$25 00
17	2.17	1.64	5.54	3.48	2.37	11.39	....	9.02	8.00	1.41	1.00	18 33	19 00
13	1.92	2.05	4.38	3.63	3.43	11.44	....	8.01	8.00	11.06	10.00	24 88	29 00
59	2.52	2.46	5.32	4.78	2.92	13.02	....	10.10	10.00	6.97	5.00	25 24	28 50
36	2.99	2.87	3.58	3.92	4.77	12.27	12.00	7.50	8.00	9.70	10.00	27 04	31 00
15	2.33	1.23	2.06	4.16	3.34	9.56	8.00	6.22	....	6.95	5.00	20 81	24 50
43	1.43	1.23	4.44	3.14	3.88	11.46	8.00	7.58	....	4.57	2.50	17 74	24 25
75	1.17	0.82	7.28	3.56	5.50	16.34	7.00	10.84	....	3.49	2.50	19 75	20 00
75	2.39	2.46	4.02	3.70	2.32	10.04	10.00	7.72	8.00	9.66	10.00	24 56	30 00
24	3.06	3.28	3.82	4.50	3.35	11.67	9.00	8.32	7.00	*5.03	5.00	24 79	28 00
15	2.15	1.43	6.84	2.67	3.44	12.95	9.00	9.51	7.00	12.25	10.00	28 40	30 00
83	1.83	1.64	3.92	3.64	2.03	9.59	8.00	7.56	7.00	11.01	10.00	23 76	28 00
32	1.83	1.64	4.42	4.36	2.17	10.95	10.50	8.78	9.00	6.36	6.00	20 95	29 00
79	1.79	1.64	3.82	5.18	3.54	12.54	....	9.00	9.00	2.38	4.00	18 35	27 00
90	3.38	2.05	7.42	1.92	0.77	10.11	....	9.34	8.00	10.99	10.00	30 14	32 00
88	1.88	1.64	9.36	2.68	0.45	12.44	10.50	11.99	9.50	2.49	2.00	20 49	28 00
64	1.64	0.82	7.34	3.62	2.20	13.16	12.00	10.96	10.00	2.53	1.00	19 40	25 00
98	0.98	0.82	8.02	2.62	1.61	12.25	11.00	10.64	10.00	1.78	1.00	16 02	25 50
93	0.93	0.82	7.38	3.20	1.81	12.39	12.00	10.58	10.00	1.70	1.00	15 82	23 00
87	0.87	0.82	2.50	5.26	2.23	9.99	8.00	7.76	7.00	1.90	1.00	13 14	20 00
28	1.28	1.03	4.50	4.95	1.31	10.76	9.50	9.45	8.50	2.19	1.50	16 05	25 00
18	5.57	4.10	2.44	3.14	1.13	6.71	7.00	5.58	5.50	1.83	1.75	25 97	28 00
02	1.02	0.82	1.30	6.33	2.73	10.36	....	7.63	8.00	2.39	2.00	14 12	18 00
06	3.52	3.28	4.62	3.80	1.91	10.33	....	8.42	8.00	10.10	10.00	28 95	37 00
02	3.10	3.28	3.68	5.03	1.65	10.36	....	8.71	9.00	9.89	10.00	27 69	33 00
58	2.25	1.64	1.80	5.28	3.22	10.30	....	7.08	7.00	6.56	3.00	21 32	26 00
47	2.67	2.46	3.94	2.69	2.07	8.70	....	6.63	8.00	10.88	10.00	25 16	31 00
71	2.51	2.46	5.10	2.94	3.30	11.34	....	8.04	11.00	4.13	3.00	20 91	28 00
42	1.85	1.64	3.58	3.56	2.27	9.41	....	7.14	8.00	7.44	7.00	20 35	25 00
77	3.25	3.28	3.64	6.08	1.79	11.51	....	9.72	9.00	*10.34	10.00	30 06	33 00
41	1.41	1.64	2.26	4.63	3.41	10.30	....	6.89	8.00	3.38	3.00	15 77	23 00
89	1.89	2.05	2.12	9.08	4.54	15.74	....	11.20	11.00	10.33	10.00	28 04	33 00
23	1.52	0.82	2.96	4.49	4.03	11.48	....	7.45	9.00	3.18	2.00	16 69	22 00

largely, if not entirely, in form of sulphate.

Complete Fertilize

Furnishing Nitrogen, Phosphoric Aci

MANUFACTURER AND BRAND.	
The J. E. Tygert Co., Philadelphia, Pa.	
Bone Phosphate	C
Fish, Bone and Potash	D
Ten Per Cent. Sweet Potato Guano	
Vineland Grain Co., Vineland, N. J.	
Potato Manure	V
Bone Phosphate	
J. K. Waddington, Salem, N. J.	
Clover Leaf Phosphate	S
Geo. M. Wells, Moorestown, N. J.	
Prosperity Potato Manure	M
Tomato and Truck Manure	
Ten Per Cent. Truck Guano	
High-Grade Potato Manure	
Fish Guano for General Use	
J. Wenderoth & Sons, Camden, N. J.	
$25-Fertilizer	C
Ten Per Cent. Fertilizer	
Potato Fertilizer	
West Jersey Marl and Transportation Co., Woodbury, N. J.	
Our All-Crop Mixture	F
Our Special Sweet Potato Manure	E
Our Special White Potato Manure	
Bone and Potash Compounds	F
Our High-Grade Truck Manure	
W. E. Whann, William Penn, Pa.	
Chester Valley Sweet Potato and Celery Mixture	C
Chester Valley Special Potato and Truck Fertilizer	
Young & Hoffman, White House, N. J.	
Vegetable Manure	W
†J. G. Downward & Co., Coatesville, Pa.	
Special Bone Fertilizer	R
Royal Bone Phosphate	
†I. P. Thomas & Son Co., Philadelphia, Pa.	
Ammoniated Dissolved Bone and Potash	Fl
Bone and Potash	Cl
†Williams & Clark Branch, New York City.	
Potato, Hop and Tobacco Manure	Bl

† 1901 samples, not previously reported.

Complete Fertilizers

Furnishing Nitrogen, Phosphoric Acid and Potash.

ogen.			Phosphoric Acid.							Potash.			
From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Ammonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
.64	1.64	1.85	7.44	2.40	2.59	12.43	11.00	9.84	9.00	2.13	2.50	$18 10	$24 00
.74	1.74	2.05	5.70	1.54	1.29	8.53	8.00	7.24	6.50	1.95	3.00	15 16	30 00
.41	1.41	1.23	6.48	1.13	0.53	8.14	8.00	7.61	7.00	8.18	10.00	19 42	29 00
.01	2.01	1.64	4.30	3.32	1.82	9.44	....	7.62	7.00	10.92	10.00	24 26	30 00
.46	1.46	1.03	6.12	3.47	1.08	10.67	10.50	9.59	8.50	2.10	1.50	16 63	25 00
.48	2.02	1.64	5.04	4.41	3.40	12.85	....	9.45	9.00	2.98	3.00	19 84	25 00
.49	2.03	1.85	4.74	1.94	3.36	10.04	....	6.68	7.00	8.54	10.00	21 82	28 00
.12	3.28	4.92	4.88	1.66	2.89	9.43	....	6.54	7.00	7.75	4.00	24 77	33 00
.09	7.43	8.20	1.78	2.73	1.98	6.49	....	4.51	4.00	4.44	4.00	32 89	44 00
.45	2.86	2.87	4.34	1.94	3.14	9.42	....	6.28	7.00	9.69	9.00	24 80	30 00
.89	2.09	2.05	4.04	3.24	4.44	11.72	....	7.28	8.00	2.59	2.00	18 10	23 00
.01	1.54	1.64	8.98	3.49	1.51	13.98	11.00	12.47	9.00	0.97	1.00	18 82	23 00
.14	7.53	8.20	3.24	3.55	1.23	8.02	6.00	6.79	5.00	4.23	4.00	35 01	45 00
.69	3.59	3.28	5.26	4.29	1.61	11.16	9.00	9.55	7.00	6.34	7.00	27 00	33 00
.15	2.15	2.05	4.80	2.90	1.12	8.82	....	7.70	6.00	4.41	4.00	19 00	22 00
.36	1.81	1.64	7.40	1.54	1.38	10.32	....	8.94	8.00	9.47	10.00	23 38	27 00
.24	2.66	2.46	5.10	2.56	1.37	9.03	....	7.66	6.00	*7.88	8.00	23 77	27 00
.91	2.35	1.64	2.34	6.01	3.33	11.68	....	8.35	8.50	3.88	3.00	20 60	24 00
.44	3.19	3.28	5.36	3.44	1.59	10.39	....	8.80	8.00	7.91	7.00	26 46	31 00
.96	0.96	0.82	5.02	2.25	0.94	8.21	....	7.27	7.00	14.35	15.00	23 02	28 00
.15	2.73	2.46	5.18	1.57	0.92	7.67	10.00	6.75	7.00	6.66	7.00	21 32	28 00
.92	1.92	1.64	3.70	7.52	0.57	11.79	....	11.22	8.00	4.04	4.00	21 22	24 00
.07	1.07	1.23	3.50	3.90	1.81	9.21	9.00	7.40	7.00	2.88	2.50	13 99	24 00
.96	0.96	0.82	3.54	4.48	1.86	9.88	9.00	8.02	8.00	2.89	2.00	14 29	22 00
.29	1.29	0.82	6.94	2.70	2.20	11.84	11.00	9.64	9.00	1.49	4.00	15 92	25 00
.59	1.59	......	4.66	6.54	5.85	17.05	....	11.20	....	2.18	....	20 48	25 00
.26	2.17	2.05	5.42	4.11	2.17	11.70	....	9.53	8.00	2.97	3.00	19 77	19 15

largely, if not entirely, in form of sulphate.

Ground Bone

Furnishing Nitrogen and Phosphoric A

Station Number.	BRAND.	MANUFACT
2682	Pure Ground Bone	Allentown Manufacturing Co.
2483	Clark's Cove Fine Ground Bone	American Agricultural Chemi
2583	Great Eastern Fine Ground Bone	" " "
2742	Williams & Clark's Fine Ground Bone	" " "
2479	Bone Meal	Armour Fertilizer Works, Balt
2482	Raw Bone, Fine	The Berg Co., Philadelphia, P
2646	Fresh Ground Bone	Bowker Fertilizer Co., Boston,
2024	Pure Steamed Bone, No. 1	J. S. Collins & Son, Moorestow
2025	Pure Steamed Bone, No. 2	" " "
2401	Pure Ground Bone	Collins & Pancoast, Merchantv
2692	Pure Bone Dust	Peter Cooper's Glue Factory, N
2410	Pure Raw Bone	Wyckoff Hendrickson, Allento
2515	Pure Ground Bone	Ira Hill, Copper Hill, N. J.
2284	Pure Ground Bone	Hires & Co., Quinton, N. J.
2561	Warranted Pure Ground Bone	Lackawanna Fertilizer and Ch
2589	Pure Ground Bone	Samuel Lederer & Son, New B
2637	Pure Raw Bone Meal	Lister's Agricultural Chemical
2267	Bone Meal	John E. Minch, Bridgeton, N.
2265	Button Bone Dust	L. Moritz, Philadelphia, Pa.
2443	Russell's Ground Bone	New Jersey Agricultural Chem
2632	Ground Bone	Ruckman Bros., New Brunswi
2288	Swift-Sure Bone Meal	M. L. Shoemaker & Co., Phila
2186	Pure Ground Bone	Somerset Chemical Co., Bound
2849	Ground Bone	Taylor Provision Co., Trenton
2128	Button Bone Dust	Emil Wahl Manufacturing Co.
2217	Bone Sawings	Winterbottom, Carter & Co., E

Ground Bone

Furnishing Nitrogen and Phosphoric Acid.

WHERE SAMPLED.	Station Number.	Mechanical Analysis. Finer than 1-50th in.	Mechanical Analysis. Coarser than 1-50th in.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phosphoric Acid.	Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
stown	2682	60	40	4.06	23.76	$28 77	$32 00
ngton	2488	50	50	2.20	29.44	26 77	26 00
ng Ridge	2583	58	47	2.81	29.82	27 22	28 00
ngton	2742	58	42	1.89	25.32	23 55	24 00
ertville	2479	62	38	2.44	25.64	25 62	26 00
ton	2482	41	59	4.01	24.28	27 50	26 00
clair	2646	53	47	2.64	26.26	26 00	35 00
stown	2024	69	31	2.47	24.86	25 64	25 00
"	2025	55	45	1.28	28.60	23 93	23 00
on Heights	2401	45	55	4.10	22.98	27 17	23 80
stown	2692	52	48	1.47	29.64	25 00	24 00
town	2410	39	61	3.89	22.48	25 80	27 00
r Hill	2515	49	51	4.01	20.80	25 71	27 00
on	2284	68	32	2.80	27.68	27 15	26 00
stown	2561	44	56	4.13	24.06	27 91	28 00
nic	2589	47	53	2.58	26.84	25 44	30 00
ington	2687	51	49	2.91	26.04	26 45	27 00
eton	2267	69	31	3.94	21.44	27 45	28 00
	2265	89	11	2.75	25.40	28 32	28 00
well	2443	33	67	3.40	22.74	24 19	28 00
Brunswick	2632	60	40	2.56	26.92	26 58	25 00
ton	2288	63	37	4.87	25.68	32 78	30 00
land	2186	41	59	3.86	21.82	25 41	26 00
bury	2849	65	35	2.22	27.10	26 27	25 50
lstown	2128	64	36	3.89	24.88	27 99	26 00
Harbor City	2217	96	4	3.79	27.02	33 41	27 00

Miscellaneous Fertili

Furnishing Phosphoric Acid and Nitro

MANUFACTURER AND BRAND.	
Armour Fertilizer Works, Baltimore, Md.	
Phosphate and Potash, No. 1	Lar
Star Phosphate	Ha
American Agricultural Chem. Co., New York City.	
Chicopee Harvest Favorite	We
Clark's Cove Atlas Bone Phosphate	Fle
Great Eastern Soluble Bone and Potash	Bas
Pacific Dissolved Bone and Potash	Hig
Packers' Union Acidulated Bone	Mt.
Quinnipiac Dissolved Bone and Potash	Wa
Quinnipiac Soluble Dissolved Bone	Eve
Read's Alkaline Bone	Che
Williams & Clark's Dissolved Bone and Potash	Mil
Bowker Fertilizer Co., Boston, Mass.	
Superphosphate with Potash	Nev
E. Frank Coe Co., New York City.	
High-Grade Dissolved Bone and Potash	Ski
S. M. Hess & Bro., Philadelphia, Pa.	
Soluble Bone and Potash	Rin
Lackawanna Fertilizer and Chem. Co., Moosic, Pa.	
Alkaline Bone	Bap
Lister's Agricultural Chemical Works, Newark, N. J.	
Animal Bone and Potash, No. 2	Rec
Alkaline Bone	Leb
R. H. Pollock, Baltimore, Md.	
Victor Bone Phosphate	Mil
Lester Shurts, Neshanic Station, N. J.	
Corn and Oats Fertilizer	Nes
Rufus W. Smith, Elmer, N. J.	
Superior Fertilizer	Elm
Somerset Chemical Co., Bound Brook, N. J.	
Degelatinized Bone	Mod
I. P. Thomas & Son Co., Philadelphia, Pa.	
Special Alkaline Bone	Titu
Alkaline Bone	
Improved Animal Bone	
Improved Animal Bone	Fre
Special Dissolved Bone and Potash	Wh
Oak Leaf Phosphate	"
Trenton Bone Fertilizer Co., Trenton, N. J.	
Dissolved Tankage	Nev

Miscellaneous Fertilizers

Furnishing Phosphoric Acid and Nitrogen or Potash.

	itrogen.			Phosphoric Acid.							Potash.		Value of 2,000 lbs. at Station's Prices.	Selling Price of 2,000 lbs. at Consumers' Depot.
									Available.					
	From Organic Matter.	Total Found.	Total Guaranteed.	Soluble in Water.	Soluble in Amonium Citrate.	Insoluble.	Total Found.	Total Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
	......	......	......	8.60	1.54	1.12	11.26	12.00	10.14	10.00	2.11	2.00	$12 38	$17 00
	......	......	......	13.04	1.08	0.30	14.42	16.00	14.12	14.00	....	....	†5.7	16 00
	......	......	......	9.24	3.37	1.61	14.22	13.00	12.61	12.00	....	....	†7.1	18 00
	......	......	......	11.84	2.40	2.02	16.26	15.00	14.24	14.00	....	....	†4.2	12 00
	......	......	......	5.56	3.98	2.29	11.83	11.00	9.54	10.00	2.49	2.00	12 58	18 00
	......	......	......	4.30	5.56	2.56	12.42	11.00	9.86	10.00	2.24	2.00	12 78	18 00
	......	......	......	10.84	2.96	1.49	15.29	15.00	13.80	14.00	....	....	†5.1	14 00
	......	......	....	3.72	6.46	2.02	12.20	11.00	10.18	10.00	2.05	2.00	12 73	18 00
	......	......	......	10.80	2.43	2.43	15.66	15.00	13.23	14.00	....	....	†5.3	14 00
	......	......	......	6.30	3.82	2.58	12.70	11.00	10.12	10.00	3.28	2.00	13 94	18 00
	......	......	......	4.06	5.84	2.68	12.58	11.00	9.90	10.00	2.24	2.00	12 87	15 00
	......	......	......	5.24	5.09	2.51	12.84	12.00	10.33	10.00	1.25	1.00	12 39	13 50
	......	......	......	6.28	3.81	3.85	13.94	12.50	10.09	10.50	1.82	2.00	13 18	20 00
	......	......	......	4.36	6.18	1.36	11.90	11.00	10.54	10.00	2.17	2.00	12 93	19 00
	......	......	......	6.16	1.61	0.37	8.14	10.00	7.77	8.00	1.71	1.62	9 37	16 00
	......	......	......	7.28	2.66	2.54	12.48	11.00	9.94	10.00	1.79	2.00	12 48	22 00
	......	......	......	7.48	2.34	1.48	11.30	....	9.82	10.00	*1.78	2.00	12 19	15 00
	......	......	......	2.00	6.50	1.57	10.07	10.00	8.50	9.00	1.37	1.00	10 30	16 50
	......	......	......	10.06	2.66	2.28	15.00	13.00	12.72	12.00	3.26	3.00	16 40	18 00
	......	......	......	1.72	7.81	2.08	11.06	12.00	9.03	10.00	2.08	2.00	11 61	14 00
	1.14	1.14	1.23	0.08	15.74	13.50	29.32	24.75	15.82	....	....	....	24 98	18 25
	......	......	......	3.98	6.50	1.48	11.96	12.00	10.48	10.00	4.43	4.00	14 84	25 00
	......	......	......	6.30	4.23	1.53	12.06	12.00	10.53	10.00	2.53	2.00	13 29	25 00
	1.10	1.10	1.64	6.02	5.29	8.50	19.81	20.00	11.31	....	....	....	18 34	26 00
	1.81	1.81	1.64	6.50	5.04	6.83	18.37	....	11.54	10.00	....	....	20 24	21 00
	......	......	......	8.64	3.20	0.93	12.77	12.00	11.84	10.00	3.28	2.00	15 00	20 00
	......	......	......	1.20	8.34	4.00	13.54	14.00	9.54	12.00	....	....	†6.8	13 00
5	3.29	3.54	4.10	5.90	6.20	0.40	12.50	11.00	12.10	10.00	....	....	23 95	0 00

sh largely, if not entirely, in form of sulphate. †Cost per pound in cents of available
oric acid.

Sundry Materials.

2008. Lime Kiln Ashes. Made by White McAfee, N. J. Sent by Nelson Crissey, Glenwood.

2132. Canada Wood Ashes. Made by Jo now, Ontario, Canada. Sent by W. M. Brown, C sample.

2133. Canada Wood Ashes. Made by Jo now, Ontario, Canada. Sent by W. M. Brown, C sample.

2743. Canada Wood Ashes. Made by Jo now, Ontario, Canada. Sent by G. H. Dobbs, Berr

2747. Canada Wood Ashes. Sold by B Co., Boston, Mass. Sent by P. J. Staats, Bound B

2578. Prepared Lime. Made by G. & Plymouth Meeting, Pa. Sent by College Farm.

2680. Prepared Lime and Potash. Ma H. Corson, Plymouth Meeting, Pa. Sent by Colleg

2681. Oyster Shell Lime. Made by R. Brunswick, N. J. Sent by College Farm.

2750. Blue Lime. Made by Wrightsville Li ville, Pa. Sent by W. Y. Holt, Flemington, N. J.

	2008	2132	2133	2743	2747	257
	%	%	%	%	%	%
Phosphoric Acid	1.83	2.18	1.48	1.02	1.60	......
Potash	1.59	6.59	5.76	4.50	3.84	......
Lime	44.92	42.56	32.14	37.42	31.87	48.7
Valuation per ton	$2.65	$8.29	$6.94	$5.32	$5.12	......
Selling price per ton	*.....	$10.75	$10.75	$10.50	$10.50	$11.0

* 15 cts. per bushel.

2001. Tannery Refuse. Sediment after h with potash, etc. Sent by Samuel DeCou, West M

2002. Tannery Refuse. Inner coatings of by machinery. Sent by Samuel DeCou, West Moo

2003. Tannery Refuse. Lime and hair. DeCou, West Moorestown.

2016. Garbage Ashes. From crematory a Sent by Bruno Pollman, Trenton.

2196. Oil Cake Waste. From oil cake me E. S. Dobbs, Mount Ephraim.

2197. Wool Waste. Sent by E. S. Dobbs,

Soot. From linoleum works. Sent by H. I. Budd, olly.

	2001	2002	2003	2016	2196	2197	2398
	%	%	%	%	%	%	%
....	1.70	12.98	1.45	0.39	6.78	2.79	0.48
cid....................................	1.68	0.19	0.88	2.22	1.01	0.88	0.20
....	0.06	0.27	0.16	1.47	0.66	8.20	0.22
per ton................................	......	.....	......	$3.00	$5.00	$2.50	......

Bone Residue. Made by Somerset Chemical Co., Bound J. It contains a trace of nitrogen, 0.52 per cent. soluble, cent. reverted, 2.26 per cent. insoluble, and 36.06 per cent. phoric acid.

Unnamed Fertilizer. Made by Kirkwood Marl Co., l, N. J. Sent by C. T. DeCou, Ellisburg. Selling price, r ton; valuation, $6.32. It contains 0.70 per cent. nitro- per cent. total and 2.94 per cent. available phosphoric acid per cent. potash.

Tobacco Stems. Made in Reading, Pa. Sent by G. ell, Vineland. It contains 0.43 per cent. nitric and 2.37 organic nitrogen, 0.65 per cent. phosphoric acid, and 5.54 potash. Selling price, $10 per ton.

Bat Guano. From deposits near Uvalde, Texas. Sent Babcock, New Brunswick. It contains 2.79 per cent. 2.63 per cent. ammoniacal nitrogen, 6.34 per cent. organic 1.72 per cent. soluble, 1.68 per cent. reverted, and 0.24 per luble phosphoric acid and 1.20 per cent. potash.

Average Analyses of Fertilizing Materials.

he establishment of this Station a large number of analyses n made of agricultural chemicals, refuse materials, guanos, es, ashes, animal excrement, etc. These have been pub- m time to time in the Annual Reports, but for convenience ce they are now collected here. In the tables which follow ound the average, and, where more than one analysis has de, the maximum and minimum percentages found of tial plant-food ingredients, nitrogen, phosphoric acid and Where determined, the form of the nitrogen and the phos- cid is also shown. While in all cases the essential ingre- ve been determined and are here reported, a blank under essential does not necessarily imply the absence of that nt. In addition to the materials sold regularly for fer- urposes, the tables contain a number of analyses of fruit uit tree prunings, and the vines of several of the more t vegetables.

bles include 156 different materials, and represent 2,687

Number of analyses.	FERTILIZING MATERIAL.	Moisture.	NITROG	
			Maximum.	Minimum.
1	Alcohol waste, wood			
114	Ammonia, sulphate of		21.20	16.2
27	Ammonite		14.21	10.0
1	Ashes, apple pomace			
5	Ashes, cottonseed hull			
2	Ashes, crematory			
1	Ashes, hemlock			
1	Ashes, hickory			
1	Ashes, licorice root			
8	Ashes, lime kiln			
1	Ashes, muck			
1	Ashes, oak			
5	Ashes, leached wood			
69	Ashes, unleached wood			
8	Basic slag			
89	Blood, dried		14.58	7.3
1	Blood, meat and bone			
8	Bone ash			
29	Bone, button		4.35	2.7
8	Bone, degelatinized		1.33	1.1
54	Bone, dissolved		4.18	1.3
458	Bone, raw ground		6.98	1.1
1	Bone residue			
52	Bone, steamed		3.35	0.7
2	Bone and meat		2.17	1.9
1	Broom-corn seed	8.88		
7	Castor pomace		6.19	4.1
1	Clay, nitrate-bearing	3.40		
2	Corena settlings		2.36	0.1
1	Cottonseed hulls			
80	Cottonseed meal	7.60	7.53	3.8
1	Cracklings			
1	Feather refuse			
12	Fish, crude		6.47	3.9
187	Fish, dried		11.40	4.3
4	Floats			
1	Flue dust			
2	Garbage refuse		0.39	0.0
1	Guano, bat, California, dried			
1	Guano, bat, Mexico			
1	Guano, bat, Texas			
1	Guano, Carib			

		NITROGEN.			PHOSPHORIC ACID.					
	Average.	Nitrates.	Ammonia.	Organic.	Soluble.	Reverted.	Insoluble.	Lime.	Magnesia.	Sulphuric acid.
	0.05							41.54		
			20.45							
				11.88						
	11.88									
2	26.55				1.40	6.61	1.58			
1	1.95							22.00		
	3.67							54.52		
	4.56							36.29		
	0.07							28.00		
4	1.92							41.47		
	0.22					1.02	6.72	0.34		
	9.37							29.65		
5	0.69							28.75		
7	5.02							33.04		
						5.45	13.69			
				12.07						
				2.28	0.26	6.84	15.87			
					16.75	0.75	0.32			
				3.61		6.81	18.64			
			0.46	0.76		15.30	13.07			
				2.61	6.06	6.22	4.16			
				3.67		7.69	14.88			
				0.09	0.52	33.28	2.26			
				2.02		7.51	20.93			
				2.04	6.78	0.90	1.36			
	0.52			1.71						
				5.44						
	0.18	1.00						12.78		
0	0.31			1.25						
	1.08			0.69						
8	0.81			6.34						
				13.22						
				14.76						
				4.87						
				7.98						
						2.08	34.51			
				0.05		0.25	1.00			
7	1.82			0.20				7.92		
	6.27		0.29	1.61	3.04	9.62	4.48			
	0.52	2.03		0.74		2.47	2.77			
	1.20	2.79	2.68	6.34	1.72	1.68	0.24			
						1.41	17.51			

Number of analyses.	FERTILIZING MATERIAL.	Moisture.	NITRO	
			Maximum.	Mi
1	Guano, Cayman Island			
7	Guano, Orchilla			
1	Guano, Penguin Island			
7	Guano, Peruvian		7.45	4
8	Hair waste		10.48	2
1	Hemp waste			
5	Hoof meal		15.11	12
1	Horn meal			
2	Horse meat		8.87	7
1	Iron tailings			
124	Kainit			
1	Kiln dust			
12	King crab		10.56	8
3	Leather, raw		7.56	7
1	Leather, steamed			
1	Leather, treated			
4	Leaves, apple	59.32	1.07	0
4	Leaves, cherry	61.20	0.82	0
4	Leaves, peach	63.54	1.40	1
8	Leaves, pear	47.94	1.21	0
8	Leaves, plum	60.46	1.16	0
3	Leaves, quince	61.02	0.91	0
1	Licorice residue	56.07		
1	Lime, blue			
1	Lime, gas			
2	Lime, marble			
1	Lime, prec. carbonate of			
4	Lime, prec. phosphate of			
1	Lime, prepared			
1	Lime, prepared, and potash			
1	Lime, saltpetre			
2	Lime sand	10.83		
2	Lime, oyster shell			
1	Lime, soft-clam shell			
5	Lime, slaked			
2	Lime, stone			
1	Lime, Wonder			
1	Linseed cake waste			
22	Linseed meal	9.46	6.45	5
1	Manure, Belgian hare	50.94		
11	Manure, cow, solid fresh	84.93	0.43	0
11	Manure cow, solid and liquid, fresh	86.31	0.54	0

...SH.		NITROGEN.			PHOSPHORIC ACID.					
	Average.	Nitrates.	Ammonia.	Organic.	Soluble.	Reverted.	Insoluble.	Lime.	Magnesia.	Sulphuric acid.
						2.80	23.11			
						5.78	11.28			
.40	2.02		4.88	1.58	8.28	8.70	6.97			
.13	0.15			6.01						
	0.19			0.57						
				13.72						
				14.85						
				8.28						
						1.18	24.77			
.89	12.55									
	2.52			4.46						
				9.47						
				7.54						
				6.87						
				7.22						
.66	0.75			1.01						
.44	0.56			0.70						
.48	0.69			1.82						
.51	0.64			0.92						
.67	0.95			0.91						
.44	0.70			0.79						
				0.69						
								54.09		
			0.59					88.54		
								71.82	8.88	
								51.20		
						26.87	2.01			
								48.76		
	8.57							41.88		
								80.64		
								28.04	1.16	
								75.19		
								50.52		
								52.78	27.18	
								27.89	19.68	
	0.62					0.46	1.18	48.92		
	0.66			6.78						
.64	1.86			5.59						
	0.58						0.08	1.01		
.13	0.21	0.01	0.08	0.31						
.20	0.88	0.01	0.11	0.34						

Number of analyses.	FERTILIZING MATERIAL.	Moisture.	NITI
			Maximum.
5	Manure, cow, solid leached	78.79	0.60
5	Manure, cow, solid and liquid leached	80.71	0.63
1	Manure, duck	....	....
3	Manure, hen	57.60	1.23
3	Manure, pigeon	57.66	4.06
38	Marl	....	....
1	Marl, shell	....	....
11	Muck	59.21	1.89
2	Muck, dried	....	1.45
1	Mussels	68.19	....
1	Peanut pulp	....	....
1	Phosphoral	....	....
1	Phosphorus works refuse	....	....
2	Plaster, Cayuga	18.26	....
11	Plaster, Nova Scotia	19.90	....
1	Plaster, Nova Scotia, calcined	....	....
2	Plaster, Onondaga	17.10	....
1	Porpoise scrap	....	....
9	Potash, bisulphate of	....	....
48	Potash, double sulphate of	....	....
52	Potash, high-grade sulphate of	....	....
286	Potash, muriate of	....	....
1	Potash, nitrate of, from tobacco extract	....	....
1	Potash, phosphate of	....	....
2	Potash, prussiate of, waste	....	....
11	Poudrette	....	1.88
2	Prunings, apple	58.58	0.34
2	Prunings, cherry	52.24	0.31
1	Prunings, grape-vine	48.61	....
3	Prunings, peach	49.40	0.65
4	Prunings, pear	50.87	0.45
6	Prunings, plum	47.68	0.58
2	Prunings, quince	49.18	0.42
1	Saltpetre waste	....	....
1	Sea pumpkin	7.29	....
1	Sewage, East Orange	57.18	....
1	Slug, ground (horn pith)	....	....
199	Soda, nitrate of	....	16.44
2	Soot	....	0.48
1	Street sweepings	....	....
1	Sturgeon, dried	5.52	....

	NITROGEN.			PHOSPHORIC ACID.					
Average.	Nitrates.	Ammonia.	Organic.	Soluble.	Reverted.	Insoluble	Lime.	Magnesia.	Sulphuric acid.
0.28	......	0.02	0.45	......	......	......	......	......	......
0.48	......	0.07	0.48	......	......	......	......	......	......
0.84	......	......	0.67	......	......	0.01	......	......	......
0.44	......	0.84	0.70	......	......	0.15	2.51	......	......
0.96	......	......	2.29	......	......	0.20	2.78	......	......
0 88	......	......	......	......	......	......	2.89	......	......
0.06	......	......	......	......	......	......	80.00	......	......
0.16	......	......	0.58	......	......	......	0 15	......	......
0.15	......	......	1.86	......	......	......	0.56	......	......
0.18	......	......	C.90	......	......	......	15.84	......	......
1.21	......	......	8.52	0.26	0.26	......	......	......	......
......	......	......	......	......	4.61	44.79	......	......	......
0.28	......	......	0.14	0.68	0.84	0.80	......	......	......
......	......	......	......	......	......	......	20.61	......	29.48
......	......	......	......	......	......	......	81.01	......	44.17
......	......	......	......	......	......	......	89.54	......	56.46
......	......	......	......	......	......	......	26.67	......	88.08
......	......	......	12.00	......	......	......	......	......	......
84.17	......	......	......	......	......	......	......	......	......
25.47	......	......	......	......	......	......	......	......	......
49.48	......	......	......	......	......	......	......	......	......
51.17	......	......	......	......	......	......	......	......	......
40.78	9.94	......	0.47	......	......	......	......	......	......
49.96	......	......	......	......	......	......	......	......	......
6.21	......	......	......	......	......	......	......	......	......
0.45	0.06	0.24	0.94	0.47	2.87	0.50	......	......	......
0.19	......	......	0.82	......	......	......	......	......	......
0.15	......	......	0.80	......	......	......	......	......	......
0.87	......	......	0.86	......	......	......	......	......	......
0.24	......	......	0.52	......	......	......	......	......	......
0.24	......	......	0.48	......	......	......	......	......	......
0.21	......	......	0.86	......	......	......	......	......	......
0.29	......	......	0.87	......	......	......	......	......	......
1.02	0.85	......	......	......	......	......	......	......	......
0.87	......	......	1.47	......	......	......	......	......	......
0.10	......	......	0.52	......	......	......	11.06	......	......
......	......	......	4.79	......	......	......	......	......	......
......	15.89	......	......	......	......	......	......	......	......
0.24	......	......	0.88	......	......	......	......	......	......
0.19	......	......	0.18	......	......	......	......	......	......
......	......	......	4.45	......	......	......	......	......	......

Number of analyses.	FERTILIZING MATERIAL.	Moisture.	NITROG	
			Maximum.	Minimum.
120	Superphosphate, bone-black	....	....	....
17	Superphosphate, double	....	....	....
7	Superphosphate, English	....	....	....
261	Superphosphate, S. C. rock	....	....	....
1	Sylvinit	....	....	....
92	Tankage	....	9.12	2.95
2	Tankage, beef	....	4.34	3.35
1	Tankage, concentrated	....	....	....
4	Tankage, dissolved	....	5.02	2.97
3	Tankage, garbage	11.50	2.95	0.64
4	Tankage, hog	....	7.00	4.90
1	Tannery refuse, sediment	....	....	....
1	Tannery refuse, hide coatings	....	....	....
1	Tannery refuse, lime and hair	....	....	....
5	Texana manure	....	0.98	0.69
4	Tobacco dust	....	2.53	1.03
1	Tobacco leaf	....	....	....
7	Tobacco stems	....	2.89	1.70
2	Tobacco and sulphur	....	2.42	2.85
1	Tomato pomace	....	....	....
22	Tops, asparagus	59.93	1.06	0.41
4	Vines, bean	78.33	0.72	0.59
7	Vines, pea	69.56	1.00	0.39
1	Vines, sweet potato, red	17.20	....	....
1	Vines, sweet potato, yellow	13.10	....	....
6	Vines, tomato	37.19	0.96	0.83
1	Waste, household, animal	58.70	....	....
1	Waste, household, vegetable	84.46	....	....
1	Wool combings	....	....	....
4	Woolen waste	....	7.96	6.66
12	Wool waste	....	3.27	2.00

TASH.		NITROGEN.			PHOSPHORIC ACID.					
nimum.	Average.	Nitrates.	Ammonia.	Organic.	Soluble.	Reverted.	Insoluble.	Lime.	Magnesia.	Sulphuric acid.
......	......	......	......	......	15.52	0.88	0.58	......	......	......
......	......	......	......	......	34.96	4.08	1.49	......	......	......
......	......	......	......	......	14.41	0.72	1.24	......	......	......
......	......	......	......	......	10.17	2.68	3.07	......	......	......
......	4.88	......	......	......	......	......	......	......	......	......
......	......	......	......	6.28	......	......	......	......	......	......
......	......	......	......	3.85	......	......	......	......	......	......
......	......	......	......	11.18	......	......	......	......	......	......
......	......	......	......	......	7.19	3.54	0.71	......	......	......
0.61	0.91	......	......	2.08	......	......	......	7.51	......	......
......	......	......	......	6.02	......	......	......	......	......	......
......	0.06	......	......	1.70	......	......	......	......	......	......
......	0.27	......	......	12.98	......	......	......	......	......	......
......	0.16	......	......	1.45	......	......	......	......	......	......
0.56	0.76	0.31	......	0.51	0.67	1.65	2.59	......	......	......
1.01	1.37	0.20	......	1.30	......	......	......	......	......	......
......	1.70	1.45	......	1.78	......	......	......	......	......	......
4.91	6.68	0.69	......	1.68	......	......	......	......	......	......
6.78	7.82	0.82	......	1.57	......	......	......	......	......	*0.91
......	0.18	......	......	0.42	......	......	......	......	......	......
0.57	0.82	......	......	0.67	......	......	......	......	......	......
0.40	0.51	......	......	0.66	......	......	......	......	......	......
0.30	0.61	......	......	0.67	......	......	......	......	......	......
......	1.44	......	......	1.69	......	......	......	......	......	......
......	1.69	......	......	2.46	......	......	......	......	......	......
0.19	0.87	......	......	0.88	......	......	......	......	......	......
......	0.30	......	......	1.64	......	......	......	......	......	......
......	0.54	......	......	0.30	......	......	......	......	......	......
......	0.27	......	......	10.80	......	......	......	......	......	......
0.19	0.21	......	......	7.36	......	......	......	......	......	......
1.15	2.11	......	......	2.57	......	......	......	......	......	......

hur.

FODDERS AND FE

I.

CONCENTRATED FEEDING

The Feeding Stuffs Law

The Legislature of the State of New Jersey, passed a law regulating the sale of feeding stuf the same manner as the sale of fertilizing mate for the quarter century past. A copy of the fu be sent to anyone interested, upon application. requires:

1. That every lot or parcel of certain conc (for domestic animals) sold in this State sha in a conspicuous place on the outside, a printed

The number of net pounds contained.
The name or trade-mark of the material.
The name of the manufacturer or shipper.
The percentage of protein contained and the contained.

If the feeding stuff is sold in bulk, or in pac purchaser, this statement shall be furnished by the purchaser.

2. A certified copy of this statement shall be of the Experiment Station in the month of N accompanied, when requested, by a sample of t

3. The feeding stuffs which are required to c visions of the law include:

Brewers' grains, dried,	**Ma**
Cerealine feeds,	**Me**
Cocoanut meals,	**Mi**
Corn and oat chop,	**Oa**
Cottonseed meals,	**Pe**
Gluten meals, feeds,	**Pe**
Hominy feeds,	**Ric**
Linseed meals,	**Su**
Maize feeds,	**Sta**

and all similar materials.

he following feeding stuffs are exempted from the requirements aw:

l kinds of hay and straw.
ne whole seeds of wheat, barley, rye, oats, Indian corn, buckwheat and broom corn, and the unmixed meals made from the entire grains of any of these.
ne meals made from pure grains ground together.
ne brans and middlings of wheat, rye and buckwheat when separate and unmixed with any other substances.

hould any of these materials, otherwise exempt, be mixed or ated with any substance for the purpose of sale, the package contains it, or in which it is offered for sale, must have plainly or indicated thereon the true composition of the mixture, or racter of the adulteration.

he Experiment Station is authorized to have collected samples y kind of material used in the feeding of domestic animals, to them and to publish the results. Penalties, varying from $25), are provided for violations of the law.

The Sampling and Analysis.

y in the fall of 1901 the Experiment Station made ready to ut the second annual inspection of feeding stuffs under the law. illiam P. Allen had been permanently added to the Station's nd to him solely was assigned the duty of collecting the samples hout the entire State. Eighteen counties of the State were ghly inspected, particular pains being taken with those counties h the inspection of the previous year had, through lack of time, perficial. Seven hundred and seventy-eight samples, or 249 han the year before, were drawn and sent to the Experiment .

e were carefully numbered and verified as received, and 558 nalysed, with the results as tabulated upon succeeding pages. rk this year, therefore, includes 89 more samples than the fore, from which it is believed that the inspection has been as h and exhaustive as could be desired, even though 220 were d from analysis. A score or more of the latter were discarded the samples had deteriorated and, therefore, did not correctly nt the original goods; the balance were omitted, because they mples of already more than duplicated goods.

The analyses of the samples selected were made
Station's Chemical Department in accordance with
Association of Official Agricultural Chemists, as
They include the determination of protein and fa
and in some cases of fiber or other constituents. (
taken to secure accuracy, and analyses have, in n
been triplicated when the results have not been in
antee or with normal composition. When the ci
case seemed to warrant, a microscopical examinati

The Classification of Feeds.

The purpose of the law, by authority of which
is twofold—first, it is to the effect that certain fe
anteed, and guaranteed correctly; second, it is to
the feeding stuffs from adulteration. The work of
fore, consists in verifying the accuracy of the
examining the various feeding stuffs for contami
tion. The feeds divide themselves naturally, there
groups in accordance with their character in this r
samples received, 426 belong to the group of wh
required, and 352 belong to the group of which the

The feeds of the guaranteed class are further cl
the oil cake meals, which include the pure residues
out of oil; the corn products, which include the s
from the manipulation of the maize kernel; the
tillery products, which explain themselves; the fe
include all cases of ground material compounded
feed substitutes, which consist of certain materials,
which are offered for this purpose; and, finally,
ground meats and poultry foods.

The feeds of which guarantees are not requir
follows: the wheat materials (bran, middlings,
feed); buckwheat, rye and barley products; corn
corn and oats ground together; feeds made from
ground together; flaxseed meal and three materials
character.

Guarantees and Actual Composition.

the 426 samples received, all of which should be accompanied ;uarantee, 166 were found to be otherwise; in the case of 138 se, however, the guarantees were filed at the Experiment Station manufacturer, and will be published in the tables of analyses e information of all concerned. Nevertheless, it must not be ered that the filing of this information with us is a substitute guarantee which is missing in the sale of the goods. We have eason to believe that there are numerous cases in which we have 'urnished with guarantees and other information that has been eld from the purchaser. In most cases the manufacturer, how-is probably not at fault, as often the dealers are careless with gs, especially when they transfer to barrels, boxes or bins.

other point in the matter of guarantees is that they should be ably accurate, and honest attempts to give the composition of ods as found. When a manufacturer, or other party, responsible alt sprouts, with 25.22 per cent. of protein; hominy meal, with per cent. of protein; oat feed, with 9.79 per cent. of protein, dulterating material, with 2.69 per cent. of protein, guarantees ind every one of these to contain but one per cent. of protein, y think he is complying with the letter of the law; he certainly with its spirit. Purchasers of these goods should not imply the high-grade character of, for instance, the malt sprouts, with rantee of one per cent., that all the materials with this low ntee are high grade; they should not even have faith in the uation of the genuineness of the malt sprouts itself. On her hand, all of the feed products of another company suffer mparison by being guaranteed high on the supposition of an tely moisture-free condition—a condition which may be obtained n-drying, but which does not continue very long thereafter. The content of these samples, therefore, rarely reaches guarantee.

e hundred and forty-six individual brands are represented by 26 samples requiring guarantees. Of these brands 125 are accom-d by guarantees in the case of every one of their samples; two s were guaranteed in some of their samples, but not in others; ineteen brands were in every case devoid of tag, statement or in-tion of any character. This is 13 per cent. of the total number ed, which is a marked improvement over last year, when 32 per of the total number of brands requiring it carried no guarantee.

The brands examined this year are represented by
these 287 were guaranteed, and in 211 of the latter w
fulfilled. In other words, 68 per cent. of the sa
fulfill their promise, which is a further improvem
before, when only 60 per cent. accomplished this en

The samples defective this year are, in addition
carried no guarantee, 51 which did not contain the
promised, 16 similarly deficient in fat and 9 in bot
There are still, therefore, in a possible 287, 60 cases
protein, the most important constituent of a purc
year there were 87 in 289. The dairymen and ot
State may, therefore, be congratulated on the effect
providing a feed inspection, even though the same
in the infancy of its operation. If consumers will
tees, when guarantees are due, an unguaranteed fe
rare as an unguaranteed fertilizer.

The Purity of the Feeds.

Among the feeds which are guaranteed, the main
to is whether the guarantee is fulfilled. If this is
manufacturer delivers the total amount of nutrie
would seem as if enough has been done, and noth
the sample is contaminatel. This is the case i
linseed meal, of which one contains an oat prod
some corn; nevertheless they are above guarantee.
however, than their duplicates which carry the sa
is to be deplored that a standard material of this
not be strictly pure, as well as up to guarantee, and
that the contamination has been accidental.

In the case of a sample of malt sprouts, which
the goods were not accompanied by a guarantee and
for this double violation of the law should be detern

Among the 249 samples of materials, in the
law does not require guarantees, 14 have been fo
with foreign material. The adulterations may
follows:

'heat Bran contains corn.
'heat Bran contains corn, oats, weed-seed and cockle.
'heat Bran contains coffee hulls (cornaline).
rown Middlings contains rice hulls.
'heat Feed contains corncob.
uckwheat Brans contain an excess of hulls.
uckwheat Bran contains peanut.
orn Meals contain cob.
orn and Oats contain oat hulls in excess.
laxseed Meal contains wheat.

ition, five corn meals are low grade in protein; they show no of adulterants, but are probably bolted meal, originally in- or human consumption.

all these adulterations merit the severest condemnation, it a matter of congratulation that in a season when feeds have n and the temptation has been great, over 94 per cent. of les of standard feeds, of which no guarantees are required, n uncontaminated.

Low-Grade Feeds (Feed Substitutes).

count of the shortage in the corn crop, and the consequent rice of all feeding stuffs, many materials which ordinarily dered as worthless offal of milling, or of other manufacturing , have been attracted to market in order to participate in prices now ruling. As instances, may be mentioned fine- at hulls, rice hulls, coffee hulls and cornstalks, which have nd not only as adulterants and forming parts of mixtures, clear, and themselves masquerading as feeds.

s are apt to be misled in the purchase of such materials, he price asked, judged from the prices of standard feed in years, would indicate worth which they do not possess, and the absence of an advance in the prices of dairy products ympathy with that in the prices of feeds renders attractive osed economy in the purpose of the latter.

nical purchase, however, does not imply the purchase of st-priced feeds; what is secured for the money is the im- consideration. Many of the waste products alluded to are utely worthless, but it is important that purchasers should at they are and what relation they bear to the standard n most cases they are not feeds at all, but fine-ground that are essentially inferior to the common roughage of the

farm. Purchasers should not be deceived in such a case by false claims or a fancy name, suggesting good quality or good origin. The Station, believing the matter of sufficient importance, issued a bulletin of warning under date of February 14th, 1902, and the advice then given is here repeated:

Purchase nothing unless with the material is furnished the definite guarantee which the law requires shall accompany all kinds of feed, except a few products like bran, middlings, corn meal, &c. These are excepted because the law characterizes any tampering with them as adulteration, to be dealt with accordingly. All other by-products and mixtures must be accompanied by a statement of composition.

We regret to say that this has not always been the case. Customers have been furnished with a name and a price. Subsequent demand by the Station has elicited a guarantee from the manufacturer or jobber, which, if furnished with the material, would certainly not have promoted its sale.

Average Composition and Selling Prices.

The Experiment Station this year omits from the tables the detailed publication of the dealers' prices of the several feeds. These were in every case recorded, however, and the average prices of the different kinds of feeding stuffs and of the different proprietary brands have been calculated.

The following table shows the average selling prices of the several feeds for animals, with their average composition, arranged in the order of their protein content:

	Protein. %	Fat. %	Selling Price.
Cottonseed Meal	44.40	10.71	$30 24
Linseed Meal	35.49	8.90	36 25
Chicago Gluten Meal	35.07	5.64	29 50
Crackerjack Dairy Feed	30.80	11.96	27 50
Buckwheat Middlings	27.89	7.45	22 00
Dried Brewers' Grains	26.57	7.26	22 91
Gluten Feeds	25.88	3.75	27 30
Malt Sprouts	25.56	3.01	21 00
Cocoanut Meal	23.76	14.02	20 00
Grano Gluten Feed	23.05	10.37	21 50
Buckwheat Bran	22.62	6.66	23 00
Feeding Flour	20.71	5.64	23 33
Sucrene Dairy Feed	19.78	8.66	26 00
Germ Oil Meal	19.60	8.67	26 50
Dried Distillers' Grains	19.45	8.44	21 67

	Protein. %	Fat. %	Selling Price.
Feed	19.16	4.47	29 00
dlings	18.61	6.43	27 33
eat Feed	17.52	5.18	25 78
eat Bran	16.97	5.27	25 54
ings.	16.81	3.64	25 00
d.	16.76	4.48	....
Feed.	16.51	4.60	20 00
eat Bran	15.96	4.63	25 70
iry Feed	15.85	4.21	24 56
dlings	15.21	3.85	28 14
e Feed	14.64	5 56	29 99
	14.12	3.53	23 00
r Corn, Oats and Barley.	13.67	6.42	30 75
eed, No. 1.	13.65	5.05	20 00
Mixtures	11.42	4.94	26 97
eal (Feed).	11.36	8.18	27 77
Feed	10.79	3.56	15 00
(Sugar Feed)	10.73	5.81	19 66
ed	10.70	4.07	23 25
al	10.64	4.10	30 00
'eed	10 43	7.88	27 69
s (Mixed Grains)	10.43	3.41	28 33
(Corn and Oats	10.05	3.92	29 69
Feed	9.79	3.85	20 75
'eed	9.62	7.91	26 75
n and Oat Feed	9.56	4.70	25 61
	9.54	2.09	25 25
	9.09	4.32	28 95
and Oat Feed	9.04	4.43	23 50
at Chop	8.89	3.59	26 00
and Oat Feed	8.63	3.08	25 00
thers' Oat Feed	8.49	3.78	16 75
eed	7.71	2.94	20 58
	7 63	2.71	23 80
Feed	7.35	2.62	19 50
Feed	4.85	1.99	18 88
lt's Oat Feed	4.84	1.72	20 00
eed, No. 2.	4.03	1.28	....
ce Oat Feed.	3.30	1.06	21 50
l"	2.94	1.20	17 50
	2.69	0.58	20 00
Feed	2.54	0.78	20 00

The Selection of Feeds.

An inspection of the foregoing table shows the well-known fact that the price of a feed is no index to its value from the standpoint either of nutrients contained or of suitability to the usual farm purposes. The distinguishing feature of the various feeds, the content of protein, has therefore been made the basis of classification. Feeds of high protein content are purchased for the express purpose of improving the ration by the addition of protein, the hay, corn fodder, ensilage, &c., which forms the balance of the ration being deficient in this ingredient.

Materials which are low in protein are therefore not suitable objects of purchase for this purpose, since they themselves are, at best, balanced rations, or else require the addition of protein feeds the same as the farm products do. As farmers usually have an abundance of low-grade farm products, these feeds appeal only to the city feeders of horses and stall-fed cattle, where all the feeding material must be purchased.

It remains for the purchaser to select, bearing this distinction in mind. The list from which his selection may be made is composed of a half dozen pretty well defined groups. They range in protein content from more than 40 per cent. to less than 5 per cent., and include some of the most valuable feeds, as well as some of the veriest trash. The groups may be outlined as follows:

1. Cottonseed, linseed and Chicago gluten meals and crackerjack dairy feed (a low-grade linseed meal), furnishing from 30 to 45 per cent. of protein, and costing approximately from $27 to $36 per ton.

2. The by-products of the manufacture of starch, glucose, spirits and beer, cocoanut meal, feeding flour (wheat) and buckwheat bran and middlings, furnishing from 19 to 28 per cent. of protein, and costing approximately from $20 to $28 per ton.

3. The wheat and rye brans, middlings and feed, &c., and the H. O. Dairy and Quaker Dairy feeds, furnishing from 15 to 19 per cent. of protein, and costing from $20 to $29 per ton.

4. Corn bran (sugar feed), cerealine feed, hominy feed and the artificial feed mixtures, furnishing from 10 to 15 per cent. of protein, and costing from $15 to $30 per ton.

5. Low-grade feeds, largely oat chop and oat hulls, furnishing from 7 to 10 per cent. of protein, at from $16 to $29 per ton, and con-

many cases, of fiber (hulls, &c.), to the extent of one-fourth
ht.

substitutes, furnishing less than 5 per cent. of protein, at
per ton, and consisting of from one-fourth to one-half fiber.

Summary.

ie 146 distinct brands of feed received, and which should be
l, 19 were devoid of tag, statement or guarantee.

umers are advised to purchase nothing unless with the ma-
urnished the definite guarantee which the law requires shall
all kinds of feed, except a few products like bran, mid-
n meal, &c.

he 287 samples which were guaranteed, and of which an
on was made, 76 failed in their promises, 60 of these being
n protein.

ng the 249 samples of feeds not required to be guaranteed,
und to be contaminated or adulterated with foreign matter,
offal of milling.

e are on the feed market a considerable number of very in-
ls, which consist of oat hulls, rice hulls, coffee hulls, etc.,
not form a profitable purchase at any price.

uying feeds to supplement his home-grown supply, the
s aim should be to secure digestible and palatable protein
ost reasonable terms and in the most economical forms.
f of the different and distinct kinds of feeds in the tables
eet his requirements in this respect. Therefore, study the
on of feeds as shown in their guarantees and in the tables
s.

OIL CAKE MEALS.

Cottonseed Meal.

PRIME BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place o Samplin
	American Cotton Oil Co, New York City.	
2285	J. C. Smith & Wallace Co.	Newark
2419	D. F. Hendrickson	Woodbury
2457	Fithian & Pennell	Bridgeton
2506	Mixner & Mickel	Bridgeton
2560	Trenton Mills and Elevator Co	Trenton
	Average	

CANARY BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place o Samplin
	R. W. Biggs & Co., Memphis, Tenn.	
2287	Wilkinson, Gaddis & Co	Newark
2348	Vroom & Butler	Somerville
2585	J. E. Stevenson & Co	Trenton
2586	Stults Bros	Trenton
2608	C. H. Snyder & Son	Freehold
	Average	

OWL BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place o Samplin
	F. W. Brode & Co., Memphis, Tenn.	
2426	Peterson & Smith	Woodstown
2688	C. C. Dempsey	Gloucester
2716	W. D. Rogers & Co	Moorestown
	Average	

GREEN DIAMOND BRAN

Station number.	Manufacturer or Jobber and Dealer.	Place o Samplin
	Chapin & Co., Philadelphia, Pa.	
2292	A. Cyphers	Newark
2468	W. O. Garrison	Bridgeton
2215	W. H. Ingersoll	Hamburg
	Average	

OIL CAKE MEALS.

Cottonseed Meal—Continued.

STAR BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Cole, Cleaveland & Curley, New York City.		%	%	%	%
2168	C. A. Wilson Co.	Deckertown	46.97	43.00	10.50	9.00
1182	Simmons & Martin	Deckertown	46.17	43.00	10.05	9.00
	Average		46.57	43.00	10.28	9.00

COFCO BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Cotton Oil and Fiber Co., Norfolk, Va.					
1083	Sharpless & Bro.	Camden	41.11	43.00	11.68	9.00
1085	Taylor Bros	Camden	44.83	43.00	9.58	9.00
462	J. K. Waddington	Salem	41.59	43.00	11.54	9.00
498	C. G. Lippincott	Salem	41.69	43.00	11.98	9.00
508	Sheard & Brooks	Vineland	41.81	43.00	11.05	9.00
519	Clure & Niggin	Vineland	41.66	43.00	12.37	9.00
596	S. L. Pancoast	Mullica Hill	40.83	43.00	10.50	9.00
722	Hopkins & Lippincott	Moorestown	42.18	43.00	11.21	9.00
	Average		41.96	43.00	11.23	9.00

LILY BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Hunter Bros., St. Louis, Mo.					
274	Jaqui & Co.	Morristown	45.13	43.00	10.85	9.00

SITLEY & SON'S BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Sitley & Son, Camden, N. J.					
159	Sitley & Son	Camden	42.69	43.00	11.58	9.00

TAR HEEL BRAND.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	D. R. Worman, Philadelphia, Pa.					
54	Davis, Colson & Co	Woodstown	46.48	43.00	9.94	9.00
95	R. W. Smith	Elmer	43.48	43.00	11.62	9.00
96	Hires & Co.	Quinton	43.18	43.00	9.47	9.00
	Average		44.38	43.00	10.34	9.00

OIL CAKE MEALS.

Linseed Meal.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	American Linseed Co., Chicago, Ill.		%	%	%	%
2002	J. Halpin	Elizabeth	38.19	32.00	8.89	5.00
2079	J. E. Lovett & Son	Hackensack	*33.17	32.00	6.95	5.00
2025	C. E Pountney	Elizabeth	38.69	36.00	8.06	6.00
2286	Wilkinson, Gaddis & Co	Newark	38.19	36.00	8.17	6.00
2107	J. English	Paterson	37.68	36.00	7.63	6.00
2011	Cranford Flour and Feed Store	Cranford	38.02	32.00	8.70	5.00
2448	D. F. Hendrickson	Woodbury	37.55	36.00	6.20	6.00
2456	Fithian & Pennell	Bridgeton	30.83	32.00	11.72	5.00
2030	Taylor Bros	Camden	33.51	32.00	7.36	5.00
2080	Vile & Son	Jersey City	35.35	32.00	7.87	5.00
2118	J. A. Lydecker	Paterson	37.31	32.00	7.54	5.00
2347	Vroom & Butler	Somerville	35.59	32.00	7.24	5.00
2594	H. Banker	New Brunswick	34.46	32.00	6.75	5.00
2602	C. H. Snyder & Son	Freehold	35.84	36.00	6.67	6.00
2078	P. O'Blenis	Paterson	34.48	32.00	7.77	5.00
2081	Carscallan & Cassidy	Jersey City	36.53	36.00	7.64	6.00
2082	Meyer & DeVogel	Paterson	36.29	36.00	6.79	6.00
2596	C. W. Russell	New Brunswick	37.49	36.00	7.08	6.00
2627	F. D. Wikoff	Red Bank	36.77	36.00	8.18	6.00
2650	J. Guire & Bro	West End	36.C5	36.00	7.43	6.00
2712	W. D. Rogers & Co	Moorestown	38.10	32.00	9.26	5.00
	Average		36.19	†36.00	7.80	†6.00
	The Grove Linseed Oil Co., Philadelphia, Pa.					
2538	S. L. Pancoast	Mullica Hill	31.51	34.00	11.38	5.00
2694	C. C. Dempsey	Gloucester	31.97	34.00	10.99	5.00
	Average		31.74	34.00	11.19	5.00
	Hauenstein & Co., Buffalo, N. Y.					
2164	Hart & Iliff	Newton	37.89	37.82	7.72	7.54
	Hunter Bros., St. Louis, Mo.,					
2482	W. O. Garrison	Bridgeton	38.11	34.00	9.91	6.50
2517	Klure & Niggin	Vineland	37.94	34.00	8.33	6.50
	Average		38.03	34.00	9.12	6.50
	Metzger Seed and Oil Co., Toledo, Ohio.					
2098	Miller & Bertholf	Jersey City	37.11	32.00	7.22	5.00
2099	A. Hannibal	Hoboken	37.89	32.00	6.98	5.00
	Average		37.50	32.00	7.10	5.00

* Contains corn.

† Guarantee filed by manufacturer.

OIL CAKE MEALS—CORN PRODUCTS.

Linseed Meal—Continued.

NUFACTURER OR JOBBER AND DEALER.	PLACE OF SAMPLING.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.
Linseed Oil Co., Minneapolis,					
		≸	≸	≸	≸
. Steinberg	Passaic	33.28	32.50	9.84	5.50
mith & Wallace Co	Newark	34.61	32.50	10.81	5.50
chwitz & Co.	Plainfield	35.34	32.50	10.70	5.50
Bros	Bound Brook	34.84	32.50	10.08	5.50
Post	Passaic	32.78	32.50	7.95	5.50
Average		34.16	32.50	9.68	5.50
ston & Co., Newark, N. J.					
'Brien	Passaic	*32.26	32.00	7.11	5.00
hers	Newark	35.35	32.00	7.34	5.00
& Smith	Hackensack	35.07	32.00	7.40	5.00
Average		34.23	32.00	7.28	5.00
Son, Camden, N. J.					
& Son	Camden	33.40	32.00	7.45	5.00
nknown.					
Keough	Keyport	36.27	....	12.80	....

COCOANUT CAKE.

Pressing Co., New York City.					
Iope	Madison	23.76	24.80	14.02	8.54

GERM OIL MEAL.

e Mfg. Co., Indianapolis, Ind.					
Rodgers & Co	Moorestown	17.10	15.00	8.58	8.00
Sugar Ref. Co., Chicago, Ill.					
Norton	Hightstown	22.09	24.50	8.81	9.50

CHICAGO GLUTEN MEAL.

Sugar Ref. Co., Chicago, Ill.					
Northrup	Augusta	35.47	38.00	5.43	3.02
Rogers & Co	Moorestown	34.66	37.72	5.85	2.05
Average		35.07	†38.00	5.64	†3.50

ts.
filed by manufacturer as percentages of the absolutely dry substance.

CORN PRODUCTS.

BUFFALO GLUTEN FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Glucose Sugar Ref. Co., Chicago, Ill.		%	%	%	%
2114	J. A. Lydecker	Paterson	26.01	28.50	3.38	2.50
2175	C. A. Wilson Co.	Deckertown	28.58	27.50	4.85	3.50
2186	Simmons and Martin	Deckertown	27.98	27.50	4.56	3.50
2192	R. V. Northrup	Augusta	26.48	27.00	3.07	3.00
2476	Fithian & Pennell	Bridgeton	27.21	27.50	3.27	3.00
2477	Ewen Milling Co	Alloway	25.81	27.50	3.27	3.50
2087	C. H. Kirby	Medford	26.98	27.00	3.06	3.00
2089	Taylor Bros	Camden	27.84	26.90	4.21	3.50
2148	A. N. Roe	Branchville	27.84	28.50	3.57	3.30
2379	A. A. Cortelyou	Neshanic	24.89	27.50	3.29	3.50
2380	F. F. Lear	Lambertville	26.36	27.50	3.96	3.50
2481	Davis, Colson & Co.	Woodstown	27.96	27.50	3.61	3.50
2515	A. G. Johnson	Bridgeton	26.73	27.50	2.94	3.50
2587	S. L. Pancoast	Mullica Hill	25.26	27.00	3.06	3.00
2570	Stults Bros	Trenton	27.84	27.50	3.16	3.30
2405	Jos. Smith & Co.	Stockton	27.89	27.50	3.42	3.50
2695	C. C. Dempsey	Gloucester	27.55	27.50	3.58	3.50
2728	W. D. Rogers & Co.	Moorestown	25.83	27.33	3.46	2.96
2764	T. S. Page & Co.	Columbus	26.98	27.50	4.60	3.50
	Average		26.61	*27.50	3.60	*3.50
	DAVENPORT GLUTEN FEED.					
	Glucose Sugar Ref. Co., Chicago, Ill.					
2101	P. O'Blenis	Paterson	24.16	28.50	3.94	2.50
2209	G. O. Young	Tranquility	25.21	24.18	4.34	3.75
2681	G. W. Norton	Hightstown	25.88	27.50	6.12	3.30
	Average		25.08	*27.50	4.80	*3.50
	ROCKFORD DIAMOND GLUTEN FEED.					
	Glucose Sugar Ref. Co., Chicago, Ill.					
2088	Long Dock Mills and Elevator Co.	Jersey City	26.54	26.20	4.28	2.70
2216	W. H. Ingersoll	Hamburg	25.98	27.50	3.79	3.50
	Average		26.24	*27.50	4.04	*3.50
	GRANO GLUTEN FEED.					
	Hottelet & Co., Milwaukee, Wis.					
2481	R. W. Smith	Elmer	28.05	26.00	16.87	7.00

* Guranteed filed by manufacturer as percentages of the absolutely dry substance.

CORN PRODUCTS.

PEKIN GLUTEN FEED.

MANUFACTURER OR JOBBER AND DEALER.	PLACE OF SAMPLING.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.
		%	%	%	%
...is Sugar Ref. Co., Pekin, Ill.					
...A. Reid..	Pennington	26.12	27.70	3.10	3.50

NATIONAL GLUTEN FEED.

...nal Starch Mfg. Co., New York ...					
...qui & Co	Morristown	25.83	27.10	3.18	2.90
...hos. Eggert & Co	Perth Amboy	24.95	31.70	2.80	4.30
...enton Mills and Elevator Co	Trenton	32.62	39.00	2.63	3.50
...enton Mills and Elevator Co	Trenton	22.56	27.10	4.47	3.20
... Banker	New Brunswick	22.87	31.70	2.78	4.30
...avis, Colson & Co	Woodstown	20.00	23.00	3.73	3.00
... S. Page & Co	Columbus	21.30	22.90	2.76	2.30
Average		24.30	28.93	3.19	3.36

WAUKEGAN GLUTEN FEED.

...Sugar Refining Co., Waukegan, Ill.					
... Cyphers	Newark	26.30	27.38	4.41	3.39
...ampbell, Morrell & Co	Passaic	26.97	27.38	3.09	3.39
...state J. W. Biddle	Columbus	*20.38	27.38	*3.81	3.39
Average		26.94	27.38	3.75	3.39

MISCELLANEOUS GLUTEN FEEDS.

...leyer & DeVogel	Paterson	26.57	....	4.45	....
... J. Nash	Perth Amboy	25.48	....	3.83	....
...harpless & Bro	Camden	29.54	....	3.03	....
...harpless & Bro	Camden	27.15	....	3.06	....
...aylor Bros	Camden	26.29	27.50	4.25	3.50
... K. Waddington	Salem	24.50	....	3.13	....

...ed from the average.

CORN PRODUCTS.

HOMINY MEAL.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling
	American Cereal Co., Chicago, Ill.	
2154	S. Hill	Newton
	Cambridge Cereal and Packing Co., Cambridge, Ind.	
2563	J. H. Ashton	Trenton
	Decatur Cereal Mill Co., Decatur, Ill.	
2160	Hopkins & Williams	Newton
	Fish & Co., New York City.	
2085	P. O'Blenis	Paterson
	Howell & Webster, Middletown, N. Y.	
2110	J. A. Lydecker	Paterson
	The Hudnut Co., Terre Haute, Ind.	
2288	A. Cyphers	Newark
	Hunter Bros., St. Louis, Mo.	
2600	C. W. Russell	New Brunswi
	Indianapolis Hominy Mills, Indianapolis, Ind.	
2210	G. O Young	Tranquility
	Miami Maize Co., Toledo, O.	
2141	A. N. Roe	Branchville
	Miner-Hilliard Milling Co., Wilkesbarre, Pa.	
2296	J. C. Smith & Wallace Co	Newark
	Shellabarger Mill and Elevator Co., Decatur, Ill.	
2105	J. English	Paterson
2258	J. Gardner	Dover
	Sitley & Son, Camden, N. J.	
2748	Colkitt & Thomson	Mount Holly
	Suffern, Hunt & Co., Decatur, Ill.	
2151	McDonalds & Fox	Branchville
2878	J. Van Buren	Rahway
	Average of all brands	

CORN PRODUCTS.

CEREALINE FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed	Fiber.
	Cerealine Mfg. Co., Indianapolis, Ind.		%	%	%	%	%
2068	Sitley & Son	Camden	10.16	7.88	7.18	5.99	....
2719	W. D. Rogers & Co.	Moorestown	9.87	7.88	6.97	5.45	....
2720	J. S. Collins & Son	Moorestown	10.21	7.88	6.49	5.99	....
2761	T. S. Page & Co	Columbus	8.95	7.88	7.21	5.99	....
2762	Estate J. W. Biddle	Columbus	10.21	7.88	8.81	5.00	....
2179	Simmons & Martin	Deckertown	11.28	9.00	8.18	5.82	....
2228	R. Harden	Hamburg	10.72	10.32	8.06	8.62	....
2768	Estate J. W. Biddle	Columbus	12.05	10.82	10.15	8.08	....
	Average		10.43	8.61	7.88	6.36	....

MAIZELINE FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed	Fiber.
	The Hudnut Co., Terre Haute, Ind.						
2040	Sitley & Son	Camden	9.42	10.42	9.22	9.03	....
2480	F. D. Duffield	Elmer	9.81	10.00	6.59	8.56	....
	Average		9.62	10.21	7.91	8.80	....

CORN BRAN, OR SUGAR FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed	Fiber.
	Glucose Sugar Ref. Co., Chicago, Ill.						
2159	Hopkins & Williams	Newton	13.20	14.00	4.14	3.50	9.58
2045	C. H. Kirby	Medford	12.39	13.68	4.40	3.68	12.29
2478	Ewen Milling Co	Alloway	11.16	14.60	4.25	3.50	11.83
2231	Reeve Harden	Hamburg	12.97	14.00	3.74	3.50	10.71
2179	J. K. Waddiugton	Salem	9.69	14.90	2.94	3.50	10.13
2709	C. C. Dempsey	Gloucester	12.45	14.00	3.82	3.50	10.98
	Average		11.98	*14.00	3.88	*3.50	10.91
	Howell & Webster, Middletown, N. Y.						
2198	R. V. Northrup	Augusta	10.18	9.00	5.77	1.50	11.57
	Liberty Mills, Nashville, Tenn.						
2459	R. W. Smith	Elmer	10.54	9.90	9.52	7.48	9.01
	John Rankin & Co., Chicago, Ill.						
2051	Taylor Bros	Camden	11.03	9.00	3.89	3.00	12.08
2067	B. M. Beideman	Merchantville	10.18	9.00	3.57	3.00	12.80
2186	A. N. Roe	Branchville	9.39	9.44	4.76	1.60	13.64
	Average		10.20	9.15	4.07	2.53	12.84

* Guarantee filed by manufacturer as percentages of the absolutely dry substance.

BREWERY AND DISTILLERY P

MALT SPROUTS.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.
	Chapin & Co., Philadelphia, Pa.	
2157	Hopkins & Williams	Newton
2268	Jaqui & Co	Morristown
	Average	
	H. C. Edwards, Chicago, Ill.	
2086	Taylor Bros	Camden
	Fish & Co., New York City.	
2163	Hart & Iliff	Newton
2087	P. O'Blenis	Paterson
	Average	
	F. W. Goeke & Co., St. Louis, Mo.	
2558	C. A. Reed	Pennington
2174	C. A. Wilson Co	Deckertown
	Average	
	P. C. Kamm & Co., Milwaukee, Wis.	
2115	J. A. Lydecker	Paterson
2178	Simmons & Martin	Deckertown
	Average	
	A. Meurer & Co., Milwaukee, Wis.	
2189	R. V. Northrup	Augusta
2246	R. Harden	Hamburg
	Average	
	E. P. Mueller, Milwaukee, Wis.	
2212	G. O. Young	Tranquility
2529	J. E Stevenson Co	Trenton
2049	C. H. Kirby	Medford
2561	Stults Bros	Trenton
	Average	
	M. G. Rankin & Co., Milwaukee, Wis.	
2578	Trenton Mills and Elevator Co	Trenton
	Sitley & Son, Camden, N. J.	
2065	J. R. Wilkinson	Vincentown
2490	C. G. Lippincott	Salem
	Average	
	Source Unknown.	
2106	J. English	Paterson
2096	Meyer & DeVogel	Paterson
	Average of all brands	

* Contains oat hulls.
† Omitted from the average.

BREWERY AND DISTILLERY PRODUCTS.

DRIED BREWERS' GRAINS.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Atlantic Export Co., New York City.		%	%	%	%
2756	T. S. Page & Co	Columbus	20.20	23.22	6.71	7.10
2751	Colkitt & Thomson	Mount Holly	24.27	23.22	7.30	7.10
	Average		22.24	23.22	7.01	7.10
	Chapin & Co., Philadelphia, Pa.					
2158	Hopkins & Williams	Newton	28.01	24.00	7.54	8.00
	P. C. Kamm & Co., Milwaukee, Wis.					
2116	J. A. Lydecker.	Paterson	26.78	23.85	7.19	6.18
	J. C. Klauder Estate, Philadelphia, Pa.					
2042	Taylor Bros	Camden	21.94	22.59	7.71	7.90
2048	C. H. Kirby	Medford	22.96	23.24	6.54	7.64
2041	Sharpless & Bro	Camden	23.61	23.24	7.24	7.64
2706	C. C. Dempsey	Gloucester	31.51	23.24	8.27	7.64
2743	Hopkins & Lippincott	Moorestown	27.55	31.68	7.60	6.34
2765	Estate J. W. Biddle	Columbus	29.04	22.06	9.22	6.34
	Average		26.10	*23.24	7.76	*7.64
	A. Meurer & Co., Milwaukee, Wis.					
2162	Hart & Iliff	Newton	28.74	23.00	7.66	6.00
2191	R. V. Northrup	Augusta	27.28	25.00	6.83	3.00
	Average		28.01	24.00	7.25	4.50
	E. P. Mueller, Milwaukee, Wis.					
2211	G. O. Young	Tranquility	24.65	25.38	6.50	7.25
2276	Jaqui & Co	Morristown	28.50	23.85	6.64	6.18
2591	T. Dugan.	New Brunswick	25.94	24.86	7.48	5.69
2140	A. N. Roe	Branchville	30.00	23.85	7.66	6.18
	Average		27.27	*23.85	7.07	*6.18
	Penn Grains and Feed Co., Philadelphia, Pa.					
2896	A. A. Cortelyou	Neshanic	25.51	23.30	6.48	4.97
	Sitley & Son, Camden, N. J.					
2061	Sitley & Son	Camden	31.49	31.68	8.28	6.34
	Source Unknown.					
2583	A. K. Ashby..	Burlington	28.99	....	7.82	....
2725	J. S. Collins & Son	Moorestown	26.86	21.00	7.28	7.00
2185	Simmons & Martin	Deckertown	28.85	....	6.80	....
2072	J. R. Wilkinson	Vincentown	28.78	....	7.18	....
	Average of all brands		26.57	24.79	7.26	6.42

* Guarantee filed by manufacturer.

BREWERY AND DISTILLERY P

DRIED DISTILLERS' GRAIN

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling
	Atlantic Export Co., New York City.	
2747	W. D. Rogers & Co.	Moorestown...
	Bernheim Bros., Louisville, Ky.	
2564	Trenton Mills and Elevator Co	Trenton...
	A. Meurer & Co., Milwaukee, Wis.	
2191	R. V. Northrup	Augusta ...
	Average of all brands	...

FEED MIXTURES.

COTTONSEED FEED.[1]

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.
	Southern Cotton Oil Co., Charlotte, N. C.	
2546	J. E. Stevenson Co.	Trenton

CRACKERJACK DAIRY FEE

	Cotton Oil and Fiber Co., Norfolk, Va.	
2084	Taylor Bros	Camden

SUCRENE DAIRY FEED.[3]

	American Milling Co., Chicago, Ill.	
2388	Vroom & Butler	Somerville
2424	Davis, Colson & Co	Woodstown
	Average	

[1] Cottonseed meal and hulls.
[2] Substantially a low grade linseed meal.
[3] Substantially a brewers' or distillers' grains.

FEED MIXTURES.

SCHUMACHER STOCK FEED (Corn, Oats and Barley).

...nufacturer or Jobber and Dealer	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
...ican Cereal Co., Chicago,		%	%	%	%	%
A. Lydecker	Paterson	14.16	13.00	6.36	5.00	4.10
...pkins & Williams	Newton	13.55	13.00	7.24	5.00	10.75
...ndy Bros	Metuchen	13.31	13.00	5.65	5.00	8.57
Average		13.67	13.00	6.42	5.00	7.86

YELLOW MEAL.

...-Hilliard Milling Co., ...kesbarre, Pa.						
...n Zant & Voorhees	Plainfield	10.64	9.27	4.10	6.25	2.41

MARSDEN FEED, NO. 1.

...Marsden Co., Philadelphia,						
...lkinson, Gaddis & Co	Newark	13.65	11.02	5.05	4.88	12.00

FEED MIXTURES.

GUARANTEED LOCAL FEED MIXTURES.

Station number.	Manufacturer or Jobber and Dealer.	Ingredients.	Protein. Found.	Protein. Calculated.	Fat. Found.	Fat. Calculated.	Fiber.
			%	%	%	%	%
2220	Belv dere Flour Mills Co., Belvidere, N. J...	....	9.99	9.80	2.44	3.1[illegible]	5.[illegible]
2225	N. Dufford, Hackettstown, N. J.....	....	9.76	8.86	3.10	3.45	2.[illegible]
2224	N. Dufford, Hackettstown, N. J. (City Feed)...	Corn ears and oat tailings..................	8.78	8.01	2.11	3.61	4.[illegible]
2108	J. English, Paterson, N. J...........	Hominy, oat chop, rye middlings.......	11.18	10.66	7.01	7.24	7.[illegible]
2284	R. Harden, Hamburg, N. J...........	....	12.28	10.00	7.42	5.0[illegible]	4.[illegible]
2218	W. H. Ingersoll, Hamburg, N. J.....	....	15.23	9.50	4.0[illegible]	3.0[illegible]	2.[illegible]
2044	C. H. Kirby, Medford, N. J. (Dairy Feed)...	Corn and cob, and wheat bran...........	14.75	12.48	3.92	3.24	7.[illegible]
2240	J. B. Keener, Belvidere, N. J.........	....	10.79	10.00	3.67	3.[illegible]	1.5[illegible]
2242	W. Larison, Washington, N. J.......	....	11.31	8.91	4.45	3.05	3.[illegible]
2248	G. K. & O. H. McMurtrie, Belvidere, N. J...	....	10.10	10.00	3.57	3.0[illegible]	1.[illegible]
2184	[1]J. C. Smith & Wallace Co., Newark, N. J. (Company Feed)...	Hominy, barley feed, oat hulls......	11.44	10.00	5.90	4.0[illegible]	7.[illegible]
2491	[2]Taylor Bros., Camden, N. J. (Dairy Feed, No. 2)...	Corn, light oats, wheat bran, cockle and rice hulls.......	11.68	12.62	4.05	3.06	3.[illegible]
2282	[3]F. C. Williams, Easton, Pa..........	Rye middlings, corn, oats.............	10.88	10.01	5.67	4.98	2.74
	Average............................	....	11.39	10.07	4.46	3.87	4.54

[1] Stock of John Post, Passaic.
[2] Stock of C. C. Lippincott, Salem.
[3] Stock of Kynor & Looker, Boonton.

FEED MIXTURES.

UNGUARANTEED LOCAL FEED MIXTURES.

Station number.	Manufacturer or Jobber and Dealer.	Ingredients.	Protein.		Fat.		Fiber.
			Found.	Calculated.	Found.	Calculated.	
			%	%	%	%	%
2125	Campbell, Morrell & Co., Passaic, N. J. (No. 1)...	Hominy, middlings corn meal, oat hulls, red dog, corn hulls, salt.....	14.21	11.6	8.84	6.5	5.64
2128	Campbell, Morrell & Co., Passaic, N. J. (Fancy)...	Corn, oats, hominy, rye, oat hulls, salt	10.55	9.6	8.78	4.8	8.92
2289	A. Cyphers, Newark, N. J............	Hominy, Vim oats, red dog.................	10.89	12.8	6 50	6.8	7.55
2229	J. Gardner, Dover, N. J...............	Hominy, oat feed, red dog.................	12.74	11.5	5.89	5.6	6.00
2183	Hemion Coal and Grain Co., Passaic, N. J...	Corn, wheat bran and middlings	14.10	10.4	4.90	8.1	4.68
2020	Higgins Bros., Three Bridges, N. J...	Corn, wheat, oat hulls......................	10.68	9.0	8.52	8.1	1.76
2406	Hoffman & Radcliff, Frenchtown, N. J...	....	11.18	....	1.69	....	8.12
2091	Holley & Smith, Hackensack, N. J...	Chiefly hominy chop	11.94	11.8	8.88	8.1	2.71
2109	[1]J. A. Lydecker, Paterson, N. J....	Hominy, Vim oats, Victor corn and oats	11.02	9.8	6.42	7.2	6.70
2120	Long Dock Mills and Elevator Co., Jersey City, N. J...	....	10.79	....	5.58	....	2.60
2277	[2]Martenis & Coleman, Chester, N. J...	Rye, oats, cob meal...	8.01	10.5	8.50	2.4	6.04
2148	McDonalds & Fox, Branchville, N. J...	Rye, corn, oats, hominy, red dog ..	18.66	9.2	7.11	4.1	8.41
2095	Meyer & DeVogel, Paterson, N. J.	Hominy, oat feed, middlings	11.02	8.9	6.98	6.0	5.76
2278	[3]Miller & Mott, Rockaway, N. J...	Hominy, flour middlings, oat feed.....	12.17	10.8	5.86	7.1	4.49
1848	D. Neff, North Branch, N. J...........	....	11.48	....	8.81	....	6.78
2267	The Chas. Richards Co., Dover, N. J...	Corn oat chop, rye chop, flour middlings, red dog.....	18.81	11.2	4.52	4.1	5.88
2123	J. & H. Steinberg, Passaic, N. J.....	Hominy, oat feed......	8.91	8.1	8.89	6.6	10.41
1575	Stults Bros., Trenton, N. J..	Corn, oats, bran.......	11.54	10.4	4.92	4.8	8.80
1896	Wilkinson, Gaddis & Co., Newark, N. J...	Corn, Marsden Feed, No. 1, and Marsden Feed, No. 2.......................	9.94	8.9	8.94	8.5	8.68
	Average..	....	11.45	10.2	5.42	5.1	5.19

[1] Stock of R. J. O'Brien, Passaic.
[2] Stock of E. B. Dawson, Boonton.
[3] Stock of M. M. Crane, Boonton.

FEED MIXTURES.

Oat Feeds and Corn and Oat Feeds.

QUAKER DAIRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	American Cereal Co., Chicago, Ill.		%	%	%	%	%
2028	C. H. Kirby	Medford	17.17	14.00	3.89	3.50	12.6[illegible]
2161	Hopkins & Williams	Newton	15.58	14.00	4.50	3.00	14.0[illegible]
2265	Jaqui & Co.	Morristown	15.64	12.03	4.01	2.50	14.[illegible]
2318	H. Nischwitz & Co.	Plainfield	15.45	12.08	3.79	2.50	16.[illegible]
2420	Davis, Colson & Co.	Woodstown	17.11	14.00	4.10	3.00	11.04
2557	Stultz Bros.	Trenton	15.88	12.03	4.34	2.50	14.6[illegible]
2312	Mundy Bros.	Bound Brook	15.07	14.00	4.65	3.50	13.[illegible]
2400	E. V. Parry	Clinton	15.13	13.00	4.37	3.25	13.[illegible]
2754	Estate J. W. Biddle	Columbus	15.65	14.00	4.24	3.50	13.[illegible]
	Average		15.85	*14.00	4.21	*3.50	13.[illegible]

VICTOR CORN AND OAT FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	American Cereal Co., Chicago, Ill.						
2077	C. B. Demarest	Hackensack	9.26	9.00	4.98	4.00	12.[illegible]
2111	J. A. Lydecker	Paterson	9.20	9.00	4.67	4.00	11.[illegible]
2208	G. O. Young	Tranquility	9.56	8.25	4.51	2.75	9.77
2315	Mundy Bros.	Bound Brook	9.69	9.00	4.[illegible]	4.00	10.[illegible]
2316	A. L. Cadmus	Plainfield	10.24	9.00	4.[illegible]	4.00	11.[illegible]
2422	Peterson & Smith	Woodstown	8.33	8.23	4.42	3.00	10.75
2527	J. E. Stevenson Co.	Trenton	9.87	9.00	4.70	4.00	9.[illegible]
2585	T. C. Dugan	New Brunswick	9.32	8.28	4.58	3.00	9.[illegible]
2677	G. W. Norton	Hightstown	9.69	8.75	4.85	3.75	11.[illegible]
2317	H. Nischwitz & Co.	Plainfield	9.58	8.75	4.[illegible]	3.75	11.[illegible]
2711	W. D. Rogers & Co.	Moorsetown	10.01	9.00	4.[illegible]	4.00	10.[illegible]
	Average		9.56	*9.00	4.70	*4.00	10.[illegible]

VIM OAT FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	American Cereal Co., Chicago, Ill.						
2027	J. R. Wilkinson	Vincentown	7.22	6.30	2.76	2.[illegible]	25.[illegible]
2117	J. A. Lydecker	Paterson	8.56	6.30	2.91	2.[illegible]	24.[illegible]
2284	A. Cyphers	Newark	6.61	6.30	2.91	2.[illegible]	27.[illegible]
2384	R. B. Beatty	North Branch	8.44	6.30	3.20	2.[illegible]	24.5
	Average		7.71	6.30	2.94	2.[illegible]	25.[illegible]

* Guarantee filed by manufacturer.

FEED MIXTURES.

at Feeds and Corn and Oat Feeds—Continued.

DE FI CORN AND OAT FEED.

ACTURER OR JOBBER AND DEALER.	PLACE OF SAMPLING.	PROTEIN. Found.	PROTEIN. Guaranteed.	FAT. Found.	FAT. Guaranteed.	Fiber.
& Co., Buffalo, N. Y.		%	%	%	%	%
Waddington	Salem	8.68	8.90	3.08	3.00	18.74

FISH & CO.'S OAT FEED.

Co., New York City.						
Blenis	Paterson	9.79	1.00	3.85	1.00	15.25

FRIENDS' FEED.

estern Cereal Co., Chi-ll.						
French	Plainfield	10.70	10.90	4.07	3.70	16.69
ess & Bro	Camden	*8.65	*10.09	*3.62	*3.07	*20.52
Average		10.70	10.90	4.07	3.70	16.69

BOSS CORN AND OAT FEED.

at Western Cereal Co., o, Ill.						
ons & Martin	Deckertown	8.26	7.94	4.18	4.18	18.83
& Co.	Morristown	9.81	7.94	4.78	4.18	18.45
Average		9.04	7.94	4.48	4.18	18.64

ROYAL OAT FEED.

estern Cereal Co., Chi-Ill.						
Wilson Co.	Deckertown	7.71	8.25	2.54	4.14	26.50
& Co.	Morristown	6.97	8.25	2.48	4.14	27.17
Waddington	Salem	7.86	8.25	2.84	4.14	23.74
Average		7.85	8.25	2.62	4.14	25.80

om the average.

FEED MIXTURES.

Oat Feeds and Corn and Oat Feeds—Continued.

H. O. DAIRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	The H. O. Co., Buffalo, N. Y.		%	%	%	%	%
2293	A. Cyphers	Newark	18.46	18.00	4.74	4.50	12.50
2327	C. F. French	Plainfield	19.86	18.00	4.19	4.50	9.91
	Average		19.16	18.00	4.47	4.50	11.21

H. O. HORSE FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	The H. O. Co., Buffalo, N. Y.						
2089	Vile & Son	Jersey City	14.71	12.00	5.84	4.50	8.26
2294	A. Cyphers	Newark	13.26	12.00	4.27	4.50	10.28
2701	J. S. Middleton	Camden	15.27	12.00	6.29	4.50	6.22
2736	Colkitt & Thomson	Mount Holly	15.33	12.00	6.54	4.50	7.82
	Average		14.64	12.00	5.56	4.50	8.15

MONARCH OAT CHOP.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	Husted Milling and Elevator Co., Buffalo, N. Y.						
2098	J. E Lovet & Son	Hackensack	9.32	10.40	3.56	3.27	9.67
2187	Simmons & Martin	Deckertown	8.45	10.40	3.62	3.27	7.94
	Average		8.89	10.40	3.59	3.27	8.81

TAYLOR BROS.' OAT FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	Taylor Bros., Camden, N. J.						
2068	B. M. Beideman	Merchantville	8.49	8.50	3.78	2.75	20.80

FEED SUBSTITUTES.

INDEPENDENCE OAT FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	Fish & Co., New York City.		%	%	%	%	%
128	W. H. Ingersoll	Hamburg	3.30	....	1.06	....	31.74
	HILDEBRANDT'S OAT FEED.						
	The Hildebrandt Co., Elizabeth, N. J.						
64	J. Van Buren	Rahway	4.84	....	1.72	....	30.04
	RANG'S OAT FEED.						
	Henry Rang & Son, Chicago, Ill.						
62	Taylor Bros	Camden	3.51	3.50	1.68	2.75	28.86
41	H A. Fish	Woodbury	6.18	....	2.29	....	25.34
	Average		4.85	....	1.99	....	27.10
	SITLEY'S OAT FEED.						
	Sitley & Son, Camden, N. J.						
62	Sitley & Son	Camden	2.54	3.75	0.78	2.56	32.48
	MARSDEN FEED, NO. 2.*						
	The Marsden Co., Philadelphia, Pa.						
10	Wilkinson. Gaddis & Co	Newark	4.03	....	1.28	....	28.42
	RICE MEAL.†						
	Simpson, Hendee & Co., New York City.						
11	Jaqui & Co	Morristown	2.14	2.56	0.92	1. 0	35.83
10	Trenton Mills and Elevator Co	Trenton	3.67	2.56	1.66	1.00	29.94
	P. H. Van Wagoner & Co., Philadelphia, Pa.						
	A. Cyphers	Newark	2.26	2.56	0.90	1.00	35.32
	J. English	Paterson	3.67	2.56	1.32	1.00	32.90
	Average		2.94	....	1.20	....	33.50
	CORNALINE.‡						
	Fish & Co., New York City.						
	Fish & Co	Bound Brook	2.43	1.00	0.68	1.00	58.79
	Stults Bros	Trenton	2.94	1.00	0.48	1.0(	59.69
	Average		2.69	....	0.58	....	58.24

*Cornstalks, ground after removing the pith.
† A misnomer; actually rice hulls.
‡ The inner hull of the coffee berry.

CALF MEAL AND GROUND MEAT.

AMERICAN CALF MEAL.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
			%	%	%	%
	American Cereal Co., Chicago, Ill.					
2528	J. E. Stevenson Co.	Trenton	17.24	18.00	7.81	5.00

BLATCHFORD'S CALF MEAL.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	John W. Barwell, Waukegan, Ill.					
2186	A. N. Roe	Branchville	26.18	26.00	5.66	5.00
2565	Trenton Mills and Elevator Co	Trenton	25.14	*22.00	4.66	5.00
	Average		25.66	26.00	5.15	5.00

BAUGH'S GROUND BEEF SCRAP.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Baugh & Sons' Co., Philadelphia, Pa.					
2032	Taylor Bros	Camden	56.60	57.12	17.56	[illegible]
2542	S. L. Pancoast	Mullica Hill	53.96	57.12	18.19	[illegible]
	Average		55.33	57.12	17.87	[illegible]

BLATCHFORD'S POULTRY MEAT.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	John W. Barwell, Waukegan, Ill.					
2551	C. A. Reed	Pennington	28.76	33.56	11.62	[illegible]

BOWKER'S ANIMAL MEAL.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Bowker Fert. Co., Boston, Mass.					
2425	D. F. Hendrickson	Woodbury	34.61	30.00	9.57	5.00
2339	Vroom & Butler	Somerville	36.29	30.00	14.30	5.00
	Average		35.45	30.00	12.34	5.00

BOWKER'S BEEF SCRAP.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
	Bowker Fert. Co., Boston, Mass.					
2461	Fithian & Pennell	Bridgeton	53.41	30.00	18.31	[illegible]
2004	James Halpin	Elizabeth	52.23	30.00	20.2[illegible]	[illegible]
	Average		52.82	30.00	19.29	[illegible]

* Omitted from the average.

POULTRY FEED.

AMERICAN POULTRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	American Cereal Co., Chicago, Ill.		%	%	%	%	%
172	C. A. Wilson Co.	Deckertown	14.59	18.96	6.57	5.49	8.81

H. O. POULTRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	The H. O. Co., Buffalo, N. Y.						
19	Geo. Benedict	Elizabeth	19.86	17.00	5.64	5.50	4.88
90	Holley & Smith	Hackensack	17.91	17.00	5.67	5.50	4.84
[illegible]	J. R. Stevenson Co.	Trenton	18.27	17.00	5.74	5.50	4.98
34	Hopkins & Lippincott	Moorestown	18.36	17.00	5.18	5.50	4.59
	Average		18.60	17.00	5.55	5.50	4.81

POULTRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	Hopkins & Lippincott, Moorestown, N. J.						
11	Hopkins & Lippincott	Moorestown	24.11	18.00	8.21	9.00	6.88

RICE'S POULTRY FEED.

Station number.	Manufacturer or Jobber and Dealer.	Place of Sampling.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber.
	Hopkins & Lippincott, Moorestown, N. J.						
9	Hopkins & Lippincott	Moorestown	24.74	15.00	9.09	8.00	4.80

WHEAT.

WINTER WHEAT BRAN.

Station number.	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein	Fat.	Fiber.
			%	%	%
2885	W. N. Adair & Co., Raritan, N. J.	Raritan	15.74	4.82	[illegible]
2582	A. K. Ashby, Burlington, N. J.	Burlington	16.13	4.58	[illegible]
2152	M. F. Barringer, Philadelphia, Pa.	Branchville	15.00	5.04	[illegible]
2081	B. M. Beideman, Merchantville, N. J.	Merchantville	14.88	5.06	6.57
2656	C. T. Birkett, Penn Yan, N. Y.	Long Branch	14.92	3.88	[illegible]
2512	Cornwall & Silvers, Fairton, N. J.	Fairton	15.38	4.08	[illegible]
2010	Cranford Flour and Feed Store, Cranford, N. J.	Cranford	15.46	4.66	[illegible]
2428	Davis, Colson & Co., Woodstown, N. J.	Woodstown	14.71	3.90	[illegible]
2467	Ewen Milling Co., Alloway, N. J.	Alloway	14.71	3.55	[illegible]
2470	Fithian & Pennell, Bridgeton, N. J.	Bridgeton	16.03	5.00	[illegible]
2014	Flemington Milling Co., Flemington, N. J.	Westfield	16.36	5.07	[illegible]
2692	H. A. Ford, Allentown, N. J.	Allentown	*13.14	*[illegible]	*[illegible]
2475	W. O. Garrison, Bridgeton, N. J.	Bridgeton	16.07	4.19	[illegible]
2867	Harter Milling Co., Toledo, O.	Perth Amboy	16.20	3.89	[illegible]
2842	H. E. Hawk, Easton, Pa.	North Branch	17.24	3.90	[illegible]
2483	Hires & Co., Quinton, N. J.	Quinton	†14.56	†[illegible]	†[illegible]
2092	Holley & Smith, Hackensack, N. J.	Hackensack	16.75	5.45	[illegible]
2485	Clinton Kelty, Salem, N. J.	Salem	17.28	5.34	[illegible]
2409	J. W. Kennedy, Shelbyville, Ind.	Everittstown	16.76	3.82	[illegible]
2704	G. H. Kirby, Allentown, N. J.	Allentown	15.40	4.73	[illegible]
2706	W. J. Koch & Co., Philadelphia, Pa.	Gloucester	16.24	4.42	—
2208	Lafayette Milling Co., Easton, Pa.	Andover	17.26	4.82	[illegible]
2894	Andrew Lane, Neshanic, N. J.	Neshanic	15.58	4.19	[illegible]
2489	F. H. Lloyd, Salem, N J.	Salem	14.96	4.42	[illegible]
2640	J. G. Macky, Philadelphia, Pa.	Red Bank	17.79	4.58	[illegible]
2744	Milburn Mills, Philadelphia. Pa.	Moorestown	16.64	4.90	[illegible]
2488	G. B. Mitchell, Swedesboro, N. J	Swedesboro	15.17	3.65	[illegible]
2869	Monticello Mills, Monticello, Ind.	Perth Amboy	15.78	4.30	[illegible]
2882	National Milling Co., Minneapolis, Minn.	Plainfield	16.88	3.99	[illegible]
2845	David Neff, North Branch, N. J.	North Branch	15.16	3.74	[illegible]
2254	Pursel Milling and Coal Co., Phillipsburg, N. J.	Phillipsburg	14.44	4.13	[illegible]
2440	Quaker City Milling Co., Philadelphia, Pa.	Woodbury	16.18	4.69	[illegible]
2897	A. S. Rockafellow, Flemington, N. J.	Flemington	17.38	3.66	[illegible]
2055	Sharpless & Bro., Camden, N. J.	Camden	15.83	4.37	[illegible]
2058	Sitley & Son, Camden, N. J.	Camden	15.80	4.12	[illegible]
2491	R. W. Smith, Elmer, N. J.	Elmer	17.32	4.35	[illegible]
2802	J. C. Smith & Wallace Co., Newark, N. J.	Newark	16.81	5.24	[illegible]
2612	C. H. Snyder & Son, Freehold, N. J.	Marlboro	14.89	4.66	[illegible]
2445	W. I. Stiles, Haddonfield, N. J.	Haddonfield	14.28	4.77	[illegible]
2622	H. E. Taylor, Englishtown, N. J.	Englishtown	14.54	4.55	[illegible]

*Omitted from the average—contains corn.

†Omitted from the average—contains oats, weed seed and cockle.

WHEAT.

WINTER WHEAT BRAN—Continued.

Station number.	MANUFACTURER, JOBBER OR DEALER.	PLACE OF SAMPLING.	Protein.	Fat.	Fiber.
			%	%	%
2070	Taylor Bros., Camden, N. J.	Camden	16.96	4.84	7.67
2501	L. W. Tomlinson, Bridgeton, N. J.	Bridgeton	15.69	4.24	6.12
2418	Trenton Mills and Elevator Co., Trenton, N. J.	Titusville	17.29	6.81	6.45
2499	J. K. Waddington, Salem, N. J.	Salem	15.88	4.58	8.85
2526	Washburn-Crosby Co., Minneapolis, Minn.	Vineland.	17.04	5.26	9.84
2461	Johathan Webster, Woodstown, N. J.	Woodstown	14.05	5.12	6.76
2126	Wilkinson, Gaddis & Co., Newark, N. J.	Passaic	16.40	4.47	7.78
2166	C. A. Wilson Co., Deckertown, N. J.	Deckertown	18.44	5.54	7.56
2664	J. P. Wyckoff, Manasquan, N. J.	Manasquan	16.88	4.54	5.79
	Average		15.96	4.68	7.51

SPRING WHEAT BRAN.

Station number.	MANUFACTURER, JOBBER OR DEALER.	PLACE OF SAMPLING.	Protein.	Fat.	Fiber.
2480	M. F. Barringer, Philadelphia, Pa.	Elmer	17.86	4.98	9.88
2589	Cambridge Milling Co , Minneapolis, Minn	New Brunswick	16.99	4.84	8.25
2324	L. Christian & Co., Minneapolis, Minn.	Bound Brook	16.82	5.71	10.20
2375	A. A. Cortelyou, Neshanic, N. J.	Neshanic	16.82	5.27	9.12
2290	A. Cyphers, Newark, N. J.	Newark	*15.18	*5.05	*18.76
2406	Daisy Roller Mills, Milwaukee, Wis.	Stockton	16.43	4.78	8.82
2341	Diamond Mills, Buffalo, N. Y.	Raritan	16.64	5.17	8.59
2227	Empire Grain and Elevator Co., Binghamton, N.Y.	Hamburg	16.13	4.97	7.64
2102	Joseph English, Paterson, N. J.	Paterson	16.64	5.21	8.21
2197	Hart & Iliff, Newton, N. J.	Newton	16.45	5.41	10.15
2362	The Hildebrandt Co., Elizabeth, N. J.	Rahway	17.06	5.68	7.75
2384	B. Hoffman, Ringoes, N. J.	Ringoes	17.61	5.22	9.17
2382	L. L. Holcombe, Flemington, N. J.	Flemington	17.79	4.78	7.78
2131	Hollister, Chase & Co., New York City	Passaic	16.69	5.02	8.46
2706	J. C. Hopkins, Moorestown, N. J.	Camden	15.84	4.67	8.50
2738	Hopkins & Lippincott, Moorestown, N. J.	Moorestown	17.78	5.54	9.45
2106	Howell & Webster, Middletown, N. Y.	Paterson	17.26	5.81	9.27
2564	E. C. Hutchinson Mill Co., Trenton, N. J.	Pennington	16.88	5.05	9.79
2387	J. H. Jones & Co., Lambertville, N. J.	Lambertville	17.49	5.77	9.26
2122	Long Dock Mills and Elevator Co., Jersey City, N. J.	Passaic	16.92	5.24	9.50
2509	J. G. Macky, Philadelphia, Pa.	New Brunswick	16.18	5.19	10.00
2350	Montevideo Roller Mill Co., Minneapolis, Minn.	Dover	17.04	5.57	8.46
2021	The Northwestern Cons. Mill Co., Minneapolis.	Elizabeth	16.29	5.11	10.06
2280	Pilsbury Flour Co., Minneapolis, Minn.	Morristown	16.08	4.89	9.87
2136	A. N. Roe, Branchville, N. J.	Branchville	17.19	5.75	8.46
2528	Sharpless & Bro., Camden, N. J.	Vineland	16.88	5.18	9.96
2508	Sheffield Milling Co., Faribault, Minn.	New Brunswick	16.36	5.51	8.88
2066	Simpson, Hendee and Co., New York City	Medford	16.84	5.26	8.44
2547	Taylor Bros., Camden, N. J.	Mullica Hill	17.28	5.08	9.22
2577	Trenton Mills and Elevator Co., Trenton, N. J.	Trenton	18.61	6.91	6.68

* Omitted from the average—contains coffee hulls (cornaline).

WHEAT.

SPRING WHEAT BRAN—Continued.

Station number.	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
			%	%	%
2581	C. W. Wagar & Co., Philadelphia, Pa.	Trenton	16.49	5.29	7.82
2418	Washburn-Crosby Co., Minneapolis, Minn	Frenchtown	18.84	5.11	7.06
2075	Wilkinson, Gaddis & Co., Newark, N. J.	Vincentown	16.57	5.28	8.67
2218	G. O. Young, Tranquility, N. J	Tranquility	17.70	5.32	8.68
	Average		16.97	5.27	8.51

UNCLASSIFIED WHEAT BRAN.

Station number.	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
2219	Belvidere Flouring Mills Co., Belvidere, N. J.	Belvidere	16.71	4.19	7.82
2717	Chapin & Co., Philadelphia, Pa.	Moorestown	16.80	4.81	7.57
2271	A. E. Howe, Newark, N. J. (Canadian)	Morristown	15.82	4.51	8.87
2241	J. B. Keener, Belvidere, N. J	Belvidere	16.81	4.74	8.11
2543	S. L. Pancoast, Mullica Hill, N. J.	Mullica Hill	17.44	5.19	8.41
2022	C. Pountney, Elizabeth, N. J	Elizabeth	17.02	5.52	10.12
2617	W. N. Steward, Englishtown, N. J.	Englishtown	17.52	4.61	8.17
2548	A. Thompson, Trenton, N. J.	Burlington	17.52	5.18	6.98
	Average		16.83	4.78	8.25

WHEAT FEED.

Station number.	Title.	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
				%	%	%
2267	Buckeye	American Cereal Co., Chicago, Ill.	Morristown	17.83	5.60	6.13
2401	Buckeye	American Cereal Co., Chicago, Ill.	Clinton	17.12	4.67	6.38
2150		M. F. Barringer, Philadelphia, Pa.	Branchville	17.26	4.86	6.44
2177	Royal	Brooks-Griffiths Co, Minneapolis, Minn	Deckertown	17.60	5.45	8.13
2861	Winter	Hecker-Jones-Jewell Milling Co., New York City	Perth Amboy	17.34	4.89	8.06
2156	Jersey	Kentucky Milling Co., Henderson, Ky.	Newton	*13.86	*4.10	*12.92
2144		A. Meurer & Co., Milwaukee, Wis.	Branchville	18.33	5.67	7.06
2245	King	R P. Moore Mill. Co., Princeton, Ind.	Hamburg	16.36	4.23	7.58
2165	Angola	Simpson, Hendee & Co., New York City	Deckertown	17.96	5.73	7.22
2170	Snow's	E. S. Woodworth & Co., Minneapolis, Minn	Deckertown	17.90	6.06	7.67
2618	Low Grade Wheat	Wm. N. Steward, Englishtown, N. J.	Englishtown	†11.11	†2.15	†1.58
2621	Damaged Wheat	H. E. Taylor, Englishtown, N. J.	Englishtown	†14.66	†4.98	†5.34
	Average			17.58	5.18	7.13

* Omitted from averages—contains ground corn cobs.

† Omitted from averages—whole wheat, low grade, as indicated.

WHEAT.

WHEAT MIDDLINGS (SHORTS).

ITLE.	MANUFACTURER, JOBBER OR DEALER.	PLACE OF SAMPLING.	Protein.	Fat.	Fiber.
			%	%	%
....	C. T. Birkett, Penn Yan, N. Y.	Long Branch	15.84	4.15	3.71
iddlings.....	Hopkins & Lippincott, Moorestown, N. J.	Moorestown	15.38	3.58	1.77
iddlings ...	Andrew Lane, Neshanic, N. J.	Neshanic	15.29	4.25	2.15
Middlings...	Jonathan Webster, Woodstown. N. J.	Woodstown	15.28	3.25	1.15
....	Ewen Milling Co., Alloway, N. J.	Quinton	*13.03	*2.57	*1.49
....	C. H. Snyder & Son, Freehold, N. J.	Marlboro	*12.37	*2.88	*1.48
....	M. Wyckoff, Howell, N. J.	Manasquan	14.28	4.00	2.91
erage			15.21	3.85	2.34

BROWN MIDDLINGS.

....	The Hildebrandt Co., Elizabeth, N. J.	Rahway	18.71	6.90	7.66
....	Long Dock Mills and Elevator Co., Jersey City, N. J.	Matawan	*13.94	*4.43	*14.56
....	The Northwestern Cons. Mill. Co., Minneapolis, Minn	Branchville	18.21	5.31	8.53
....	W. I. Stiles, Haddonfield, N. J.	Haddonfield	18.91	7.08	2.85
erage			18.61	6.43	6.35

FEEDING FLOUR.

White Midgs..........	W. S. Ankeny & Co., Minneapolis, Minn	Vineland	19.38	4.73	4.31
og..........	L. Christian & Co., Minneapolis, Minn.	Bound Brook	19.88	5.31	....
og..........	Jaqui & Co., Morristown, N. J.	Morristown	20.53	5.61	....
og..........	Washburn-Crosby Co., Minneapolis, Minn.	Moorestown	21.24	5.72	....
rade Shorts..	Washburn-Crosby Co., Minneapolis, Minn	Hightstown	21.22	5.98	3.30
....	Washburn-Crosby Co., Minneapolis, Minn.	Hightstown	22.61	6.01	....
....	Wilkinson, Gaddis & Co., Newark, N.J.	Matawan	20.25	5.31	....
Middlings...	Wilkinson, Gaddis & Co., Newark, N.J.	Mount Holly.	19.53	5.30	1.54
Middlings....	Wilkinson, Gaddis & Co., Newark, N.J.	West End	21.71	6.80	2.46
erage			20.71	5.64	....

from averages—contains rice hulls.

BUCKWHEAT, RYE AND B

BUCKWHEAT BRAN.

Station number.	Manufacturer, Jobber or Dealer.	P SA
2244	Wm. Larison	Washi
2579	Trenton Mills and Elevator Co	Trento
2074	J. R. Wilkinson	Vincer
2169	C. A. Wilson Co	Decke

BUCKWHEAT FEED.

2415	Jos. Smith & Co	Stockt
2308	Wilkinson, Gaddis & Co	Newar

RYE BRAN.

2043	W. G. Kirby	Medfo
2768	J. N. Smith & Bro	Pembe
	Average	

RYE MIDDLINGS.

	Hottelet & Co., Milwaukee, Wis.	
2285	W. H. Ingersoll	Hamb

RYE FEED.

2690	H. A. Ford	Allen
2609	D. E. Mahoney	Keypo
2619	W. N. Steward	Englis
2620	H. E. Taylor	Englis
	Average	

BARLEY FEED.

	J. C. Smith & Wallace Co., Newark, N. J.	
2300	J. C. Smith & Wallace Co	Newa

* Contains peanut meal.
† Contains an excess of hulls.
‡ More properly "middlings."

CORN.

CORN MEAL.

Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.
		%	%
N. Adair & Co., Raritan, N. J	Raritan	8.66	3.88
W. Ashby, Florence, N. J	Columbus	9.04	3.87
H. Ashton, Trenton, N. J.	Titusville	9.05	3.83
ry Banker, New Brunswick, N. J.	New Brunswick	9.96	4.84
ate J. W. Biddle, Columbus, N. J.	Columbus	8.73	3.71
L. Cadmus, Plainfield, N. J.	Dunellen	9.43	4.85
L. Cadmus, Plainfield, N. J.	Plainfield	8.44	3.65
mpbell, Morrell & Co., Passaic, N. J	Passaic	9.25	4.96
tan & Devlin, Matawan, N. J	Matawan	9.87	3.97
A. Close, Matawan, N. J.	Matawan	8.84	4.86
kitt & Thomson, Mount Holly, N. J	Mount Holly	8.49	5.42
Cornell, Vineland, N. J.	Vineland	8.15	3.93
nwall & Silvers, Fairton, N. J	Fairton	8.82	4.08
H. Crisman, Branchville, N. J	Branchville	8.78	3.82
rton Milling Co., Towanda, Pa.	Trenton	9.31	4.30
C. Dempsey, Gloucester, N. J.	Gloucester	8.09	4.32
mond Mills, Buffalo, N. Y.	Perth Amboy	8.81	4.13
s. Eggert & Co., Perth Amboy, N. J	Perth Amboy	9.79	4.38
mington Milling Co., Flemington. N. J	Westfield	9.64	4.09
C. Fox, Willow Grove, N. J.	Vineland	8.67	4.31
O. Garrison, Bridgeton, N. J.	Bridgeton	8.95	5.13
n Guire & Bro., West End, N. J	West End	10.10	4.66
nes Halpin, Elizabeth, N. J.	Elizabeth	9.53	4.38
ves Harden, Hamburg, N. J.	Hamburg	9.13	4.49
gins Bros., Three Bridges, N. J.	Perth Amboy	8.74	4.52
Hildebrandt Co., Elizabeth, N. J.	Rahway	9.79	4.71
Hoffman, Ringoes, N. J.	Ringoes	8.74	4.91
llister, Chase & Co., New York City	Passaic	8.30	3.23
. Hopkins, Moorestown, N. J.	Haddonfield	8 61	5.47
pkins & Lippincott, Moorestown, N. J.	Moorestown	8.73	5.62
H. Ingersoll, Hamburg, N. J.	Hamburg	9.42	3.79
L. Jones & Co, Lambertville, N. J.	Lambertville	9.05	4.17
V. Keough, Keyport, N. J.	Keyport	9.13	3.96
H. Kirby, Medford, N. J.	Medford	9.25	4.77
F. Lear, Lambertville, N. J.	Lambertville	9.43	4.36
g Dock Mills and Elevator Co., Jersey City, N. J.	Jersey City	9.36	3.82
Donalds & Fox, Branchville, N. J.	Branchville	9.36	4.60

of T. S. Page & Co.
of H. W. Van Artsdalen.
of A. Gray.
of Stults Bros.
of J. J. Nash.
of R. F. Hohenstein.
[7] Stock of Sheard & Brooks.
[8] Stock of Petty & Applegate.
[9] Stock of J. Van Buren.
[10] Stock of Passaic Feed Co.
[11] Stock of H. A. & G. H. Clement.

CORN.

CORN MEAL—Continued.

Station number	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
			%	%	%
2749	G. K. & O. H. McMurtrie, Belvidere, N. J.	Belvidere	9.66	4.12	——
2487	G. B. Mitchell, Swedesboro, N. J.	Swedesboro	9.91	4.00	——
2846	David Neff, North Branch, N. J.	North Branch	8.68	3.56	——
2684	G. W. Norton, Hightstown, N. J.	Hightstown	9.07	4.98	——
2410	E. V. Parry, Clinton, N. J. (Western)	Clinton	9.29	4.34	——
2555	C. A. Reed, Pennington, N. J.	Pennington	9.07	4.18	——
2519	[1]A. K. Richmond & Bro., Malaga, N. J.	Vineland	8.86	3.34	——
2898	A. S. Rockafellow, Flemington, N. J.	Flemington	8.88	5.21	——
2808	J. C. Smith & Wallace Co., Newark, N. J.	Newark	8.84	4.92	——
2615	C. H. Snyder & Son, Freehold, N. J.	Freehold	8.58	3.61	——
2545	J. E. Stevenson Co., Trenton, N. J.	Trenton	9.87	4.21	——
2708	[2]Taylor Bros., Camden, N. J.	Camden	9.04	4.57	——
2078	J. R. Wilkinson, Vincentown, N. J.	Vincentown	8.56	3.62	——
2647	[3]Wilkinson, Gaddis & Co., Newark, N. J.	Red Bank	9.59	4 81	——
2288	[4]F. C. Williams, Easton, Pa.	Boonton	8.82	4.88	——
2662	J. P. Wyckoff, Manasquan, N. J.	Manasquan	10.05	4.02	——
	Average		9.09	4.32	——

LOW GRADE CORN MEAL.

Station number	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
2724	J. S. Collins & Son, Moorestown, N. J.	Moorestown	6.89	2.23	——
2429	H. A. Fish, Woodbury, N. J.	Woodbury	5.28	1.85	——
2703	G. H. Kirby, Allentown, N. J.	Allentown	7.58	3.91	——
2058	Sharpless & Bro., Camden, N. J.	Camden	6.61	3.62	——
2769	J. N. Smith & Bro., Pemberton, N. J.	Pemberton	7.79	3.70	——
2416	D. R. Worman, Frenchtown, N. J.	Frenchtown	*8 74	2.03	——
2850	W. H. H. Wyckoff, Raritan, N. J.	Raritan	*8.13	1.79	——

CORN EAR OR COB MEAL.

Station number	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
2840	R. B. Beatty, North Branch, N. J.	North Branch	7.20	1.57	4.65
2222	Belvidere Flour Mills Co., Belvidere, N. J.	Belvidere	7.56	3.91	5.38
2844	David Neff, North Branch, N. J.	North Branch	7.71	2.21	5.66
2205	S. S. Wills, Andover, N. J.	Andover	8.13	3.06	3.38
2849	W. H. H. Wyckoff, Raritan, N. J.	Raritan	7.53	2.80	5.06
	Average		7.63	2.71	4.77

[1] Stock of Klure & Niggin.
[2] Stock of J. S. Middleton.
[3] Stock of F. D. Wikoff.
[4] Stock of Kynor & Looker.
* Contains traces of cob.

WHOLE GRAINS GROUND TOGETHER.

CORN AND OATS.

MANUFACTURER, JOBBER OR DEALER.	PLACE OF SAMPLING.	Protein.	Fat.	Fiber.
		%	%	%
. Apgar, Weston, N. J.	New Brunswick	9.89	8.98	2.41
ry Banker, New Brunswick, N. J.	New Brunswick	9.98	8.97	2.20
. Cadmus, Plainfield, N. J.	Westfield	9.87	4.09	2.68
:allen & Cassidy, Jersey City N. J.	Jersey City	*9.78	*8.44	*9.77
in & Devlin, Matawan, N. J.	Matawan	*8.78	*4.19	*6.61
ford Flour and Feed Store, Cranford, N. J.	Cranford	10.10	3.55	8.41
nond Mills, Buffalo, N. Y.	Passaic	*9.91	*5.58	*7.46
. Eggert & Co., Perth Amboy, N. J.	Perth Amboy	9.58	4.47	1.74
an & Pennell, Bridgeton, N. J.	Bridgeton	10.04	4.89	2.05
aington Milling Co., Flemington, N. J.	Rahway	9.76	4.19	1.86
. Ford, Allentown, N. J.	Allentown	9.87	8.50	1.80
French, Plainfield, N. J.	Plainfield	8.67	1.74	2.80
. Garrison, Bridgeton, N. J.	Bridgeton	11.25	4.94	2.85
ins Bros., Three Bridges, N. J.	Red Bank	10.21	4.08	1.09
Hildebrandt Co., Elizabeth, N. J.	Rahway	9.99	4.00	8.04
Holcombe, Flemington, N. J.	Flemington	9.07	2.00	2.71
Keough, Keyport, N. J.	Keyport	9.58	8.75	1.60
. Kirby, Allentown, N. J.	Allentown	9.18	8.15	1.22
Dock Mills and Elevator Co, Jersey City	Keyport	11.08	5.28	4.92
. Norton, Hightstown, N. J.	Hightstown	10.21	4.28	2.07
Parry, Clinton, N. J.	Clinton	10.83	4.09	1.68
& Applegate, Perth Amboy, N. J.	Perth Amboy	10.88	4.88	2.17
Snyder & Son, Freehold, N. J.	Freehold	8.70	4.84	1.76
tull & Bro., Madison, N. J.	Madison	12.91	4.98	5.00
. Tomlinson, Bridgeton, N. J.	Bridgeton	10.65	8.78	1.88
:inson, Gaddis & Co., Newark, N. J.	Matawan	9.84	2.74	2.69
Wyckoff, Manasquan, N. J.	Manasquan	10.28	4.58	1.58
Average		10.05	8.92	2.80

C. W. Russell.
R. F. Hohenstein.
Passaic Feed Co.
J. H. Jennings.
from the average—contains an excessive amount of oat hulls.

[5] Stock of R. Hance.
[6] Stock of J. Van Buren.
[7] Stock of D. E. Mahoney.
[8] Stock of W. A. Close.

WHOLE GRAINS GROUND TOGETHER.

MISCELLANEOUS GRAINS.

Station number.	Manufacturer, Jobber or Dealer.	Ingredients.	Protein.	Fat.	Fiber.
			%	%	%
2387	W. N. Adair & Co., Raritan, N. J	Corn, oats, rye	10.97	3.85	2.74
2146	C. H. Crisman, Branchville, N. J	Corn, rye, oats, wheat	11.28	4.59	2.6
2018	[1] Flemington Milling Co., Flemington, N. J.	Corn, oats, wheat screenings	10.56	4.66	1.33
2288	J. S. Hance, Hackettstown, N. J.	Rye, corn and cob, oats	8.83	2.87	2.03
2408	Joseph Huff, Everittstown, N. J.	Corn, rye, oats	9.87	1.97	1.46
2278	Jaqui & Co., Morristown, N. J	Corn, rye, oats	9.98	3.54	3.46
2391	F. F. Lear, Lambertville, N. J	Corn, rye, oats	9.76	4.69	1.73
2256	Pursel Mill and Coal Co., Phillipsburg, N. J.	Corn, rye, oats	12.86	3.80	3.16
2549	A. S. Rockafellow, Flemington, N. J		9.75	4.55	1.41
2261	H. D. White & Son, Beattystown, N. J	Corn, rye, oats	11.56	1.69	3.35
2153	[2] W. O. Williams, Portland, Pa	Corn, rye, oats	9.82	2.77	1.74
2204	S. S. Wills, Andover, N. J	Cob meal, rye, oats	9.96	2.06	1.97
2171	C. A. Wilson Co., Deckertown, N. J	Corn, rye, oats	10.42	3.22	2.28
	Average		10.43	3.41	2.28

MISCELLANEOUS MATERIALS.

FLAXSEED MEAL.

Station number.	Manufacturer, Jobber or Dealer.	Place of Sampling.	Protein.	Fat.	Fiber.
			%	%	%
2057	Sitley & Son	Camden	*17.29	30.10	....
2576	Trenton Mills and Elevator Co	Trenton	26.74	31.24	....

‡WHEAT BRAN AND OIL.

	American Can Co., Baltimore, Md.				
2775	Wm. Diecks	Orange	14.54	8.01	....
2776	Kynor & Looker	Boonton	16.38	7.57	....
2777	W. L. Smith	Livingston	15.29	8.19	....
	Average		15.40	7.92	....

SUGAR BEET PULP.

	Binghamton Beet Sugar Co., Binghamton, N. Y.				
2778	S. P. Tomkins (user)	Franklin Furnace	†1.08	0.09	....

‡NUTRIUM MILK POWDER.

	National Nutrient Co., Jersey City, N. J.				
2773	Geo. Roe (user)	Augusta	33.81	0.66	....

[1] Stock of R. F. Hohenstein, Westfield.
[2] Stock of S. Hill, Newton.

* Contains wheat.
† Contains 89.85 per cent. of water.
‡ See next page.

Wheat Bran and Oil.

This is a waste product from the manufacture of tin plate. The following account of its origin is abstracted from Thorpe's Dictionary of Applied Chemistry, as follows:

The sheets to be tinned are dipped in melted grease, such as tallow or palm oil, until all moisture has been removed and they are uniformly coated with grease. They are next dipped into the tin pot, which contains melted tin covered with a layer of grease. The sheets now receive their first coating of tin, which, however, is not perfect; after a number of manipulations to render it so, they are then cleaned from grease, usually by rubbing with bran and finishing with the woolly skin of a sheep. In France, chopped rice straw is used for cleaning the sheets, but American manufacturers have been generally content to copy the methods adopted in South Wales.

By the above process the wheat bran, according to the samples received, has acquired additional fatty matter to an amount about equal to that originally in it, without materially decreasing the content of protein. It also contains a small quantity of metallic tin, which has been brushed from the plates in the form of small scales and clots. If a small portion of the bran is stirred to a thin paste in a glass of water, the bran may be floated off and the tin will settle and become visible at the bottom of the glass. The amount of tin in these samples was trifling, and no inconvenience from this source to the animals to which it has been fed has as yet been brought to our attention.

Nutrium Milk Powder.

This material is evaporated skim-milk, and, therefore, has a high protein content—33.81 per cent. It is manufactured by the National Nutrient Co., of Jersey City, N. J., at their factory at Augusta, N. J. The Station has received a statement from the company that it "is recovered from sweet skim-milk, no acids or chemicals or ingredients being used in its recovery, nor are any foreign ingredients mixed with it afterwards." This product is manufactured for human consumption, the principal customers being bakers and confectioners; but occasionally a day's product, or a batch, is unsatisfactory for the purpose intended, when it is sold as cattle food in the immediate locality of the factory.

II.

MARKET PRICES OF COMMERCIAL FEEDS.

The gathering of statistics concerning the average market prices of commercial feeds used in the State was begun in 1891. It has been continued since, though with some changes as to method. Up to January 1st, 1900, the records represented the average price per ton for the six months preceding January 1st. Last year a change was made, which it is believed will more accurately represent the acutal prices paid for feeds, since the average prices are of feeds obtained direct from dealers for analysis under the law passed in 1900, and now in force. Besides, the averages now represent not only a larger number of samples distributed more generally over the State, but also a larger number of specific brands than have been included in previous years. Hence a comparative study of composition and prices cannot be made in all cases as yet.

The general tendency toward higher prices since January 1st, 1897, is very apparent, the prevailing prices in the spring of 1902 being, generally speaking, double what they were five years ago. The largest advances have occurred within the past two years, and were due primarily to the shortage of the corn crop, which caused that commodity to advance in price 27 per cent. in 1900–01, and to further advance 31 per cent. in 1901–02. This has caused a sympathetic advance in all the rest of the list, particularly during the past year. The feeds of high protein content, cottonseed, linseed, germ oil and gluten meal, advanced least; the advance was $2.67 per ton, on the average. The brewery products advanced $3.93, on the average. The common by-products of the milling of wheat and rye advanced an average of $5.28 per ton. Feed mixtures with corn and light oats as a base advanced $6.22 per ton. Corn meal itself advanced $6.95, while maizeline feed, cerealine feed, cob meal, hominy meal and provender advanced $7.25, $7.94, $8.39, $8.72 and $8.79, respectively.

It is difficult to see why these by-products of corn should have advanced more than corn meal itself, especially as the advance is not shared in by corn bran (sugar feed), or the gluten feeds, which advanced but $4.05 and $5.43 per ton, respectively. The average advance for all feeds was $5.74 per ton, or nearly 30 per cent. over 1900, at which time it was 12 per cent. over the year before.

——AVERAGE FOR THE

KIND OF FEED.	Jan. 1st, 1897.	Jan. 1st, 1898.	Jan. 1st,
Cottonseed Meal	$22 40	$23 00	$20
Linseed Meal	22 97	24 32	25
Germ Oil Meal................	.....	.....	.
Chicago Gluten Meal.........	14 83	16 83	19
Gluten Feeds	12 00	15 22	15
Hominy Meal	12 75	13 94	15
Cerealine Feed	.....	.....	.
Maizeline Feed	.....	.....	.
Corn Bran, or Sugar Feed.....	.....	.....	.
Malt Sprouts	10 90	12 08	1
Dried Brewers' Grains........	12 88	15 13	1
Dried Distillers' Grains.......	.....	.....	.
Sucrene Dairy Feed..........	.....	.....	.
Schumacher Corn, Oats and Barley	.....	.....	.
Local Feed Mixtures..........	.....	.....	.
Quaker Dairy Feed...........	.....	.....	.
Victor Corn and Oat Feed.....	.....	.....	.
Vim Oat Feed...............	.....	.....	.
De Fi Corn and Oat Feed.....	.....	.....	.
Friend's Feed	.....	.....	.
Boss Corn and Oat Feed......	.....	.....	.
Royal Oat Feed..............	.....	.....	.
H. O. Dairy Feed............	.....	.....	.
H. O. Horse Feed............	.....	.....	.
Monarch Oat Chop	.....	.....	.
Wheat Bran	12 81	14 10	1
Wheat Middlings	14 98	15 85	1
Brown Middlings	.....	.....	.
Feeding Flour	.....	.....	.
Wheat Feed	.....	.....	.
Buckwheat Bran	.....	.....	.
Buckwheat Feed	.....	.....	.
Rye Bran	11 13	12 44	1
Rye Middlings	14 40	15 50	1
Rye Feed	.....	.....	.
Corn Meal	14 83	15 02	1
Corn Ear Meal..............	12 60	13 67	1
Corn and Oats (Provender)....	14 29	16 69	1
Mixed Grains	.....	.....	.

III.

S IN THE FAT OF CORN MEAL DUE TO THE ACTION OF MOULDS.

rtage in the corn crop during the past season caused the n many cases, to dispose of their supply before it had operly dried, and for the same reason the millers were grind the corn almost at once. As a result much of the on the market this year shows an abnormal content of This excess of moisture not only causes a decreased per- protein, fat and the other food compounds, but also by its courages the growth of certain micro-organisms which have us effect on the food compounds of the meal.

nd[1] and Welte[2] have shown that pure cultures of *Penicil- m* and *Aspergillus nidulus* acting on sterilized bread caused ss of dry matter, as much as 75 per cent., which was ly in the carbohydrates. The total nitrogen remained un- though a part of the protein was converted into soluble mpounds. The fat and crude fiber showed a slight increase. as noted that with a marked moulding of rye and wheat decided and almost proportionate decrease in all the food s. Reitmair[4] has called attention to the fact that in peanut t content was reduced by mould from 11.90 to 0.56 per cent. observed in experiments on the preservation of olive press with a water content of 30 to 35 per cent. the fat content onths decreased from 17.51 to 9.48 per cent., while the rose from 1.18 to 73.11 per cent. Biffen[6] has found in a fungus under whose action the fat is dissipated. R. B. has shown that *Aspergillus niger* is nourished excellently nd oil as the only source of carbohydrates, and that great f it are destroyed. The mould thrives still better on free-

Vers. Stat., 1893, 43, 421.
yg., 1895, 24, 84.
hr. und Genussm., 1899, 2, 550.
Vers. Stat., 1891, 38, 386.
ngew. Chem., 1900, 635.
Botany, 1899, 13, 363.
891, 74, 300.

oleic acid. Rubner[1] has shown that the bacteria of the soil cause a breaking up and combustion of the fat. A pure soil bacteria culture in a solution of meat extract with calcium carbonate in one month destroyed 13.45 per cent. of the butter-fat present, and in one year 56.01 per cent. Spieckermann and Bremer[2] have made an extended study of the effect of moulds on cottonseed meal. Their experiments showed that, with a moisture content under 21 per cent., there was a marked destruction of fat; with 24 to 30 per cent. of moisture, complete destruction of carbohydrates marked loss of fat and slight losses of pentosans and protein; with 30 to 50 per cent. of moisture an increased destruction of protein, with the formation of ammonia, complete destruction of carbohydrates, increased loss of pentosans and a decreased loss of fat. A sample of cottonseed meal, in which the moulds were allowed to develop spontaneously, showed in a little less than six months an increase of moisture from 8.44 to 28.68 per cent. On the dry basis the fat decreased from 13.81 to 1.68 per cent., the free fatty acids increased from 10.70 to 52.10 per cent., and the total nitrogen and pentosans showed slight losses. The moulds which developed were *Eurotium repens, Eurotium rubrum, Penicilium glaucum* and *Monilia,* in the order named.

In the feed inspection this year the number of samples collected was so large that it was impossible to analyse them immediately on their receipt. When the time came for grinding the samples, it was found that nineteen of them were so mouldy and wet, although they had been tightly stoppered, that not only was grinding out of the question, but an analysis of such materials would be unfair and of little value. Accordingly those samples have been entirely omitted in our consideration. They included thirteen samples of corn meal, four of horse feeds, in which corn was the chief component, and one each of corn and oats and of cob meal.

In addition to these very mouldy såmples, seventeen samples of corn meal were found which, to the sight, were apparently normal, but which gave out a mouldy odor, and, under the microscope, showed unmistakably the presence of micro-organisms, notably *Penicilium glaucum.* However, the decomposition had not progressed so far as to prevent analysis, and the results of this analysis are shown in the following table:

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[1] Arch. Hyg., 1900, 38, 67.

[2] Landw. Jahrb., 1902, 31, 81–127.

Deteriorated Corn Meal.

Fat found.	Fat calculated.	Loss in fat.	Percentage loss in fat.	Protein.	Fat found.	Fat calculated.	Loss in fat.	Percentage loss in fat
%	%	%		%	%	%	%	
1.50	4.64	3.14	67.7	8.42	2.70	3.96	1.26	31.8
1.77	3.94	2.17	55.1	7.95	2.57	3.74	1.17	31.3
1.69	3.61	1.92	53.2	8.08	2.68	3.80	1.12	29.5
1.86	3.83	1.97	51.4	8.15	2.95	3.83	0.88	23.0
1.93	3.74	1.81	48.4	7.92	2.89	3.72	0.83	22.3
1.74	3.13	1.39	44.4	8.38	3.22	3.94	0.72	18.3
2.36	3.94	1.58	40.1	7.75	3.04	3.63	0.59	16.3
2.38	3.94	1.56	39.6	8.02	3.61	3.77	0.16	4.2
2.63	4.20	1.57	37.4	....	....	....	....	....

amination of a large number of samples of normal corn his Station has shown that on the average the percentage of it is 47 per cent. of the percentage of protein. It was felt, that for purposes of comparison it would not be unfair to hat the samples above tabulated should contain an amount ial to 47 per cent. of the protein found. The third column le was secured in this way, and the fourth and fifth columns deficiency from normal fat content and the percentage loss spectively.

be seen that these losses range from 67.7 to 4.2 per cent. of moisture in the samples would cause a lower percentage protein and fat, but such is not here the case, as is shown ly in the first sample, where with a protein percentage of e is but 1.50 per cent. of fat, where normally there should er cent. These samples were examined under the microscope idence of adulteration was detected, but the familiar mould, *n glaucum,* was found in abundance.

er to determine whether this mould was the chief factor in he losses in fat noted, the following experiment was carried ample of normal corn meal was selected in which the moist- nd protein were determined. Four portions of two grams weighed into fat extraction tubes, and were inoculated with

Penicilium glaucum, and water added to secure the following percentages of moisture, 10.73, 14.98, 32.63 and 36.24. The action of the mould was continued for nine days at an average temperature of 71° Fahrenheit. The samples were then dried and protein and fat determined in them. The following table shows the results obtained:

Tests.		Water.	Protein.	Loss in protein.	Percentage loss.	Fat.	Loss in fat.	Percentage loss.
		%	%	%		%	%	
	Original sample..............	10.73	9.54	....	....	4.33	....	....
1	" " + mould....	10.73	9.31	0.23	2.41	4.25	0.08	1.85
2	" " " "	14.98	9.43	0.11	1.16	4.12	0.21	4.85
3	" " " "	32.63	9.08	0.46	4.82	3.87	0.46	10.62
4	" " " "	36.24	9.25	0.29	3.04	3.80	0.53	12.24

While the losses shown are not great, still it is noticeable, particularly in the case of the fat, that as the percentage of moisture is increased the loss of fat increases, in test four amounting to as much as 12.24 per cent. Pressure of work prevented continuing this experiment for a more extended period, but there is no doubt that if the time covered had been three, two, or even one month, the results would have been much more striking. Certain other results which were obtained incidentally on other samples seem to bear out this view. The low percentages of fat obtained in our first examination of certain samples cast some doubts upon the accuracy of the analysis, and new determinations were made to confirm them. It was found that in every case the new results were considerably lower and in some cases excessively low. The intervals elapsing between the different analyses naturally varied considerably, but the moisture content seemed to be the dominating factor rather than the time element.

Losses of Fat in Corn Meal.

No.	Water.	Fat. First test.	Fat. Last test.	Loss.	Percentage Loss.	Time elapsed between tests.
	%	%	%	%		
37	9.96	3.23	3.15	0.08	2.48	35 days.
128	10.72	4.71	4.33	0.38	8.07	49 "
43	12.21	3.62	3.07	0.55	15.19	66 "
412	13.92	2.23	1.70	0.53	23.77	18 "
141	16.89	2.57	1.20	1.37	53.31	48 "

ble shows that with an increase of moisture content, and with nt more favorable conditions for the development of the loss of fat is shown in every case, ranging from 8.07 to r cent., omitting the first sample in which the water content ial. It has been shown by other observers that not only does favor the development of *Penicilium,* but that this develop-lf causes an increase in moisture. The effect of this is shown kingly in the case of sample 141 in the above table. On 21st it showed 2.57 per cent. fat; on February 10th, twenty r, 2.19 per cent. fat, and on March 10th, twenty-eight days y 1.20 per cent. fat, showing very clearly that with the in-levelopment of the mould larger and quicker losses of fat

impossible in the limited time at our disposal to make a ended study of the changes which the mould may have occa-the other food compounds of the corn meal, but a searching tion of these problems is planned for the near future.

IV.

TWO NEW FEED ADULTERANTS.

esent inspection has disclosed the fact that there are two terants in the New Jersey feed markets. The one consists rd, flinty hulls of the rice grain, sold under the misleading "rice meal;" the other of the inner hull of the coffee berry, er the even more misleading name of "cornaline." Four f the rice hulls and two of the cornaline, in an unmixed con-ere collected by our inspector during the present season. A nspection on the part of the purchaser would have shown he woody, fibrous nature of these materials, but when they l with standard feeds, even in quite large proportions, their is a matter of much difficulty. That these inferior materials for the purpose of adulterating feeds of recognized value is rom the fact that among the samples collected this year we sample of brown middlings, which consisted of nearly one-hulls, and one sample of wheat bran that contained con-cornaline, while a sample of linseed meal was received which of over one-fourth rice hulls. That these are not isolated

cases is proved by our correspondence with other Stations, which shows that at least three of the eastern States have found during the present season similar adulterations. It is important that these adulterants should be readily recognized by Station workers, and for that purpose certain characteristic structures of these materials are pictured and described below.

Rice Hulls.

The samples sold under the name of rice meal this season were found to consist almost exclusively of the hard, dried, flinty hulls of the rice grain. The epidermal cells of the rice hull possess marked characteristics, whether viewed in a cross or in a tangential section, but as the latter are always present and will be observed more frequently, these alone are described here. The epidermal cells may be observed directly on the slide after soaking the fragments for several

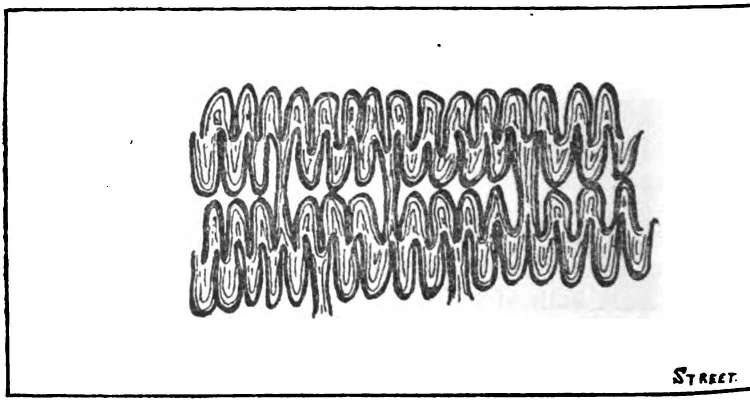

Fig. 1.
Rice hulls. Epidermal cells in chloral hydrate.

minutes in water, or still better after maceration with dilute potassium hydroxid, nitric acid or chloral hydrate. The last-named reagent was found particularly useful, as after a few minutes the cells became greatly swollen and were easily isolated. These cells are also readily colored by either an alcohol fuchsin solution or alkaline methylene blue.

The cells are arranged in several convoluted, ribbonlike rows, separated from each other by a narrow space except where occasionally a cell is lengthened out and joins the corresponding layer, as is shown in the cut (Fig. 1). They vary from 0.006 to 0.011 mm. in

width and from 0.032 to 0.043 mm. in length, and are best observed with a magnification of from 250 to 300. These cells are very characteristic, are always present in rice hulls and afford a simple and easy means for their identification.

Coffee Hulls.

The dark-colored outer hulls of the coffee berry have long been employed as a coffee substitute under the name of "Sultan Coffee," but the use of the inner hull, the parchment-like endocarp, as an adulterant has been noticed this season for the first time. The material called "cornaline" has been found to consist almost entirely of the endocarp of the coffee hull, only an occasional fragment of the dark-colored outer hull being present. When finely ground this ma-

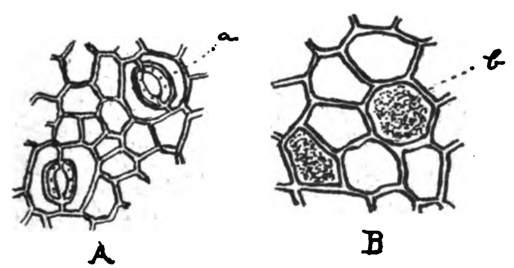

Fig. 2.

Coffee hulls. A. Epidermis, with stomata (*a*). B. Parenchyma, with minute crystals (*b*). In chloral hydrate. (After Tschirch.)

terial strongly resembles corn bran, and when mixed with wheat bran, several cases of which have been found, it can only be detected by the use of the microscope.

The fruit shell, or pericarp, of the coffee berry consists of five layers, an epidermis, a parenchyma, an obliterated layer, fibro-vascular bundles and a sclerotic layer (the endocarp).

The epidermis consists of rather small (0.033 mm.) polygonal cells, with straight, smooth walls, rather thickened on the outer side. There are no intercellular spaces, but stomata are frequently present, always surrounded by two cells placed in the shape of a crescent (Fig 2, A).

Underlying the epidermis is a parenchyma layer, consisting of

polygonal, isodiametric cells, with thick walls, and frequently containing aggregations of minute crystals. These cells are dark-brown or colorless, according to the portion of the hull which furnished them (Fig. 2, B).

Then follows an obliterated layer, the middle zone of the mesocarp, which adheres closely to the bast cells.

The fibro-vascular bundles consist of fibres of greatly varying shapes, about 1 mm. long, and from 0.020 to 0.025 mm. broad; they are found as tubes, ducts or long irregular fibres, with thick, pitted walls. The spiroids are long and narrow and generally thinner than the bast fibers.

The endocarp consists chiefly of irregular, sclerotic, spindle-shaped cells, crossing each other in all directions, and with thick, channeled walls. These cells are quite thick in the outer layer, and are pierced by fine pore-canals; in the inner layer they are much thinner (Fig. 3).

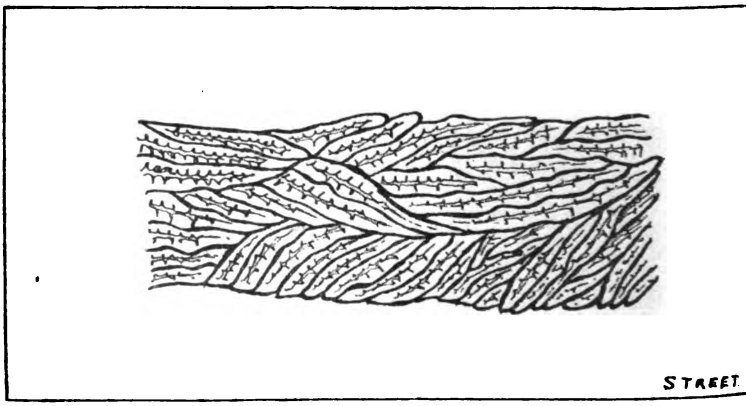

Fig. 3.

Coffee hulls. Sclerotic cells of the endocarp in chloral hydrate.

The structure of the sclerotic cells of the endocarp is very characteristic, and when viewed tangentially furnishes an easy means of detecting this form of adulteration. As in the case of the rice hulls, fragments may be observed directly after soaking for a short time in water, but more satisfactory results will be obtained by treatment with either potassium hydroxid or chloral hydrate, preferably the latter.

The accompanying cuts show in tangential section the characteristic structure of these cells, as well as the structure of the epidermis and parenchyma of the outer hulls, fragments of which will be found occasionally in the adulterant.

INVESTIGATIONS RELATIVE TO THE USE OF NITROGENOUS MATERIALS.

BY EDWARD B. VOORHEES.

These investigations were undertaken mainly to determine the relative availability and value of nitrogen in farm manure, and in the nitrogen salts and high-grade organic nitrogenous materials found in the market. In the study of these substances, there was also included the study of the changes which take place when farm-yard manures are exposed to the leaching action of rain. The changes in the manures thus exposed involve not only a loss of a portion of the fertilizing material originally contained in the manure, but they also cause a relative decrease in the availability of the portion still remaining. The soluble nitrogen, potash and phosphoric acid are very readily washed out from the unprotected manure, and the resources of the farmer for replacing the plant-food taken out of his soil by the crops are thus very materially diminished. Immense quantities of the most valuable plant-food constituents whose monetary value is great, are thus lost to the farmers of the United States. In order to determine the extent of these losses in manures, samples of cow manure of known composition and consisting of solid excreta alone, and of a mixture of solid and liquid excreta, were exposed for varying lengths of time, at the end of which they were analyzed and the results noted. The data thus obtained have been reported from time to time,[1] and the more recent analytical results presented here tend to confirm the experience of the other seasons.

The manure was carefully collected, and 100 pounds of each placed in a galvanized iron box, 8 inches deep, with a perforated bottom covered with wire gauze to prevent mechanical losses, and then exposed to the open air. Representative samples were taken from each lot, and analyzed in the laboratory. The manures were exposed from May 28th, 1901, until July 29th, 1901, that is, for a period of sixty-one days. At the end of that time the boxes were weighed, and representative samples taken and analyzed. The figures representing the analyses of the fresh and the leached manures were compared on the water-free basis, and the losses calculated.

[1] N. J. Sta. Reps., 1899, p. 97; 1900, p. 88; 1901, p. 144.

THE COMPOSITION OF THE SOLID A AND LIQUID PORTIONS OF COW

As in the preceding years, the samples lecting from a cow, well fed, a consideral manure, and of the solid and liquid manure, samples were thoroughly mixed, and adeq analysis. For the purposes of comparison, the samples used since the beginning of these ex

Fresh Manure, Solic

	1898.	1899.
	%	%
Water	85.081	85.103
Ash	1.815	2.325
Organic matter	13.104	12.572
Nitrogen (total)	0.341	0.312
" water-soluble	0.087	0.073
" as nitrates	0.015	0.026
" as ammonia	0.037	0 013
" as soluble organic	0.035	0.034
" as insoluble organic	0.254	0.239
Phosphoric acid	0.434	0.330
Potash	0.222	0.188

Fresh Manure, Solid and

	1898.	1899.
	%	%
Water	84.858	83.408
Ash	1.957	2.344
Organic matter	13.185	14.248
Nitrogen (total)	0.538	0.486
" water-soluble	0.284	0.220
" as nitrates	0.002	0.042
" as ammonia	0.162	0.170
" as soluble organic	0.120	0.008
" as insoluble organic	0.254	0.266
Phosphoric acid	0.391	0.335
Potash	0.353	0.315

The analyses of the different years sh variations. The total nitrogen in the solid per cent. to .364 per cent., and the water-so

per cent., and in the solid and liquid, fresh, from .264 per .538 per cent. for the total nitrogen, and from .088 per 284 per cent. for the soluble nitrogen. As would be expected, tions are greater in the latter case, for the moisture content variable here. Nitrates occur in very slight quantity, and in es are absent entirely. The ammonia nitrogen varies from cent. to .038 per cent. in the solid manures, and from .034 to .173 per cent. in the solid and liquid manures. The proportionate amounts of ammonia in the solid and liquid are due to the liquid manure, which furnshes ammonia hippuric acid and the urea contained in it are decomposed ria. The amounts of soluble organic nitrogen are fairly in the solid manures, but show considerable variations in and liquid manures taken together. The amounts of phos- cid in the solid manures are, in the greater number of cases, onstant, and do not differ much from the corresponding in the solid and liquid portions taken together. On the nd, there are very considerable differences in the potash of the solid, and of the solid and liquid portions. In the t ranges from .128 per cent. to .266 per cent., in the latter 75 per cent. to .727 per cent. This shows that very con- quantities of potash are contained in the liquid manure. ollowing tables give the composition of these manures, calcu- the water-free basis:

OSITION OF MANURES ON WATER-FREE BASIS.

Solid, Fresh.

	1898.	1899.	1900.	1900.	1901.
	%	%	%	%	%
...	12.166	15.607	11.849	17.507	19.490
ic matter	98 834	84.393	88.151	82.493	80.510
gen (total)	2.286	2.094	2.128	2.383	2.423
water-soluble	0 583	0.490	0.340	0.403	0.486
as nitrates	0.101	0.175	....	....	....
as ammonia	0.248	0.087	....	0.081	0.253
soluble organic	0.234	0.228	0.340	0.322	0.233
insoluble organic	1.703	1.604	1.788	1.980	1.937
horic acid	2.915	2.215	2.315	1.873	2.423
a	1.488	1.899	1.408	0.859	1.771

Solid and Liquid, Fresh.

	1898.	1899.	1900.	1900.	1901.
	%	%	%	%	%
Ash	12.924	14.127	13 687	21.619	21.765
Organic matter	87.076	85.873	86.313	78.381	78.235
Nitrogen (total)	3.553	2.929	3.576	2.529	3.685
" water soluble	1.876	1.326	1.879	0.843	1.850
" as nitrates	0.013	0.253	....	....	....
" as ammonia	1.070	1.025	0.597	0.326	1.495
" soluble organic	0.793	0.048	1.282	0.517	0.355
" insoluble organic	1.677	1.603	1.697	1.686	1.835
Phosphoric acid	2.582	2.019	2.321	1.877	3.183
Potash	2.331	1.899	2 321	4.425	6.289

It will be noticed that there are considerable variations in the ash content of the dry matter. In the solid portion it varies from 11.849 per cent. to 19.490 per cent., with an average of 15.324 per cent., while in the solid and liquid portion it varies from 12.924 per cent. to 21.765 per cent., with an average of 16.824 per cent. Similarly in the case of the nitrogen content, there is a variation from 2.094 per cent. to 2.423 per cent., with an average of 2.263 per cent. in the solid portion, and a variation from 2.529 per cent. to 3.685 per cent., with an average of 3.254 per cent. in the solid and liquid portions. The average content of phosphoric acid in the dry matter of the solid manure is 2.348 per cent., and of the solid and liquid manure it is 2.396 per cent. The average content of potash in the dry matter of the solid manure is 1.485 per cent., and of the solid and liquid portion it is 3.453 per cent.

THE COMPOSITION OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, LEACHED.

As was already stated, 100 pounds of each of the manures, whose analyses are given above, were exposed for different lengths of time. In each case the exposure resulted in the loss of greater or smaller quantities of the manures exposed. The following tabulation shows the time of exposure and the final weight of the samples:

Solid Manure.

	Original weight. lbs.	Exposed.	Final weight. lbs.
8.	100	February 4th to June 15th = 131 days	50
9.	100	February 3d to April 13th = 70 days	74
0.	100	February 2d to April 20th = 76 days.............	73
0.	100	August 9th to September 27th = 50 days.........	62
1.	100	May 28th to July 29th = 61 days..................	56.5

Solid and Liquid Manure.

8.	100	February 4th to June 15th = 131 days...........	61
9.	100	February 3d to April 13th = 70 days.............	71
0.	100	February 2d to April 20th = 76 days.............	68
0.	100	August 9th to September 27th = 50 days........	62
1.	100	May 2d to July 29th = 61 days.....................	34.5

nalyses of these residues, calculated on the water-free basis, e following results:

Solid, Leached.

	1898. %	1899. %	1900. %	1900. %	1901. %
....	14.161	13.835	11.163	18.395	24.923
ic matter........................	85.839	86.165	88.837	81.605	75.077
gen (total)......................	2.489	1.877	2.197	2.314	2.278
gen soluble in water.........	0.377	0.244	0.456	0.169	0.339
as nitrates.................	0.058	....	....	....	....
as ammonia...............	0.182	....	....	0.037	0.213
as soluble organic......	0.137	0.244	0.456	0.132	0.126
as insoluble organic....	2.112	1.633	1.741	2.145	1.939
phoric acid.....................	1.408	2.195	1.470	1.912	2.372
h.................................	0.584	1.525	1.008	0.874	1.649

Solid and Liquid, Leached.

	1898. %	1899. %	1900. %	1900. %	1901. %
....	15.282	14.051	13.570	21.354	20.547
ic matter......................	84.718	85.949	86.430	78.646	79.543
gen (total).....................	2.529	2.329	3.204	2.290	2.753
soluble in water......	0.734	0.790	1.456	0.407	0.985
as nitrates..............	0.014	....	....	....	....
as ammonia............	0.521	0.374	0.617	0.059	0.073
as soluble organic....	0.199	0.416	0.839	0.348	0.912
as insoluble organic..	1.795	1.589	1.748	1.883	1.768
phoric acid....................	1.617	2.375	1.248	2.250	3.100
h................................	1.062	1.936	1.193	3.605	4.093

The average content of ash in the dry matter of the solid leached is 16.495 per cent., as against 15.324 per cent. in the dry matter of the solid fresh. The average content of ash in the dry matter of the solid and liquid leached is 16.961 per cent., as against 16.824 per cent. in the dry matter of the solid and liquid fresh. The average nitrogen content in the dry matter of the leached manures is less than that in the dry matter of the fresh manures. In the solid fresh it is 2.263 per cent., as against 2.233 per cent. in the solid leached. In the solid and liquid fresh it is 3.254 per cent., as against 2.621 per cent. in the solid and liquid leached. As might have been expected, the proportionate losses of nitrogen are greater from the solid and liquid manure on account of the greater proportion of soluble nitrogen originally contained in it. It is quite evident that where manures are exposed the soluble constituents would be the first to vanish. By comparing the relative amounts of soluble nitrogen in the dry matter of the solid fresh and leached, and of the solid and liquid fresh and leached, the extent of such losses under the conditions of the experiment will appear. In the dry matter of the solid manure fresh, the average content of water soluble nitrogen is .460 per cent., as against .317 per cent. in the dry matter of the solid manure leached. In the dry matter of the solid and liquid fresh it is 1.555 per cent., as against .854 per cent. in the dry matter of the solid and liquid manure leached. It is quite clear, then, that the greater proportionate losses fall to the share of the soluble constituents, which, by virtue of their solubility, are also the most valuable constituents of the manure. Before taking up the discussion of the *absolute* amounts lost from the manures exposed, it will be of interest to compare the relative content of phosphoric acid and of potash in the solid manures, fresh and leached, and in the solid and liquid manures, fresh and leached. It appears that the average content of phosphoric acid in the dry matter of the solid manure fresh is 2.348 per cent., as against 1.871 per cent. in the dry matter of the solid manure leached, and 2.396 per cent. in the solid and liquid portion fresh, as against 2.118 per cent. in the solid and liquid portion leached. In the case of potash, the corresponding figures are 1.485 per cent. for the solid fresh, and 1.128 per cent. for the solid leached, and 3.453 per cent. for the solid and liquid fresh, as compared with 2.378 per cent. for the solid and liquid leached.

Losses Sustained.

In the annual report for 1901[1] the economic significance of the losses from farm-yard manures, due to leaching, is discussed at length, and it is, therefore, unnecessary to consider it here. For the sake of comparison with the more recent data, the absolute amounts of plant-food lost in the different years are again tabulated. The length of exposure determines to a great extent the amounts lost; none the less, the temperature and the season are very important factors here. Even at the low winter temperature slight changes take place in the composition of the manure exposed on account of the bacterial life in them, and as the temperature rises the activity of the bacteria is intensified, as are the decomposition losses accompanying such activity.

Solid Manure.

In 100 Pounds of Dry Matter.

Lot.	Period.		Ash.	Organic matter.	Nitrogen.	Phosphoric acid.	Potash.
1.	181 days.	Original ....lbs.....	12.166	87.884	2.286	2.915	1.488
		Loss.................lbs.....	5.085	44.915	1.041	2.211	1.196
		Per cent ....lost...	41.8	51.1	46.0	72.0	80.0
2.	70 days.	Original.........lbs.....	15.607	84.393	2.094	2.215	1.262
		Loss ....lbs.....	5.369	20.631	0.705	0.591	0.133
		Per cent.........lost...	34.4	24.4	34.0	27.0	10.0
3.	76 days.	Original.........lbs.....	11.849	88.151	2.128	2.315	1.408
		Loss.................lbs.....	3.700	23.300	0.524	1.242	0.672
		Per cent ....lost...	31.2	26.4	25.0	54.0	48.0
4.	50 days.	Original ....lbs.....	17.507	82.493	2.333	1.878	0.859
		Loss ....lbs.....	7.114	36.386	1.076	0.793	0.365
		Per cent.........lost...	40.6	44.1	45.0	42.0	42.0
5.	61 days.	Original.........lbs.....	19.490	80.510	2.423	2.423	1.771
		Loss ....lbs.....	4.033	33.962	1.011	0.952	0.749
		Per cent.........lost...	20.0	42.0	42.0	39.0	42.0
		Average original.........lbs.....	15.324	84.676	2.263	2.348	1.358
		Average loss	5.061	31.839	0.871	1.158	0.623
		Average per cent..................	33.6	37.6	38.4	46.8	44.4

[1] N. J. Sta. Rep., 1901, p. 147.

Solid and Liquid Manure Co

In 100 Pounds of Dry Matte

Lot.	Period.		Ash.	Organic matter.	Ni
1.	181 days.	Original.........lbs.....	12.924	87.076	
		Loss..................lbs.....	3.602	35.398	
		Per cent......... lost...	27.8	40.6	5
2.	70 days.	Original.........lbs.....	14.127	85.873	
		Loss .... lbs.....	4.161	24.849	
		Per cent.........lost...	29.4	28.9	4
3.	76 days.	Original.........lbs.....	13.687	86.313	
		Loss................ lbs.....	4.459	27.541	
		Per cent.........lost...	32.6	31.9	3
4.	50 days.	Original......... lbs.....	21.619	78.381	
		Loss..................lbs.....	14.252	51.248	
		Per cent.........lost...	65.9	65.4	6
5.	61 days.	Original.........lbs.....	21.765	78.235	
		Loss................ lbs.....	9.026	28.974	
		Per cent.........lost...	41.0	37.0	5
		Average original ....lbs.....	16.824	83.176	
		Average loss ....lbs.....	7.098	33.602	
		Average per cent....... lost...	39.3	40.7	5

In all cases but one, the loss, both relat greater from the solid and liquid manure whe it was from the solid manure alone. The phoric acid was about the same, although t greater loss from the solid and liquid manure The loss of nitrogen varied from 25 per cent. solid manure, and from 39 to 69 per cent. in manure. The loss of potash varied from 10 pe in the solid manure, and from 28 to 72 per liquid manure. An examination of the tabl greatest absolute losses from the solid manure took place in lot 4, notwithstanding the fac exposure in this case was far shorter than in instance. In lot 1, the length of the exposure 4 it was only 50 days. The differences in manures, leached, are in some instances even r 4 there was lost in 50 days 14.25 pounds of of the amount originally present, and 51.25 pou or 65.4 per cent. of the amount originally pre

h of exposure was so much greater, the corresponding losses) pounds and 35.40 pounds, or 27.8 per cent. and 40.6 per spectively, of the amount originally present. It appears s that the mere leaching action of rain is not sufficient in account for all the losses which take place. There is factor here which deserves attention, namely, the action of Remembering that lots 4 and 5 were exposed during the nonths, when the activity of the lower organisms is intense, es clear why the absolute losses are at times greater during er periods. On the other hand, lots 1, 2 and 3 were exposed ne period covered by the months of February, March and the case of lot 1, also, May and part of June), when the of the lower organisms is slight. This activity has a two- t on the manures under consideration. In the first place, ing down of the organic matter results in the formation of ubstances, which includes ammonia and free nitrogen. As expected, the losses due to this would involve the organic f the manure. In the second place, the bacteria, by breaking organic molecules, render a considerable portion of the soluble, and, therefore, subject to the leaching action of e mineral portion of the manure, not being volatile, cannot sed in quantity unless it is rendered soluble, and then ut by the rain. The tables show clearly that there was a nately greater loss of organic matter and of nitrogen during er, warmer periods. In order to bring this out more ly, the average daily losses in the different lots, both solid and liquid, are tabulated. It would be expected that fficient amount of rain-fall, the soluble constituents present lanure would be washed out very rapidly, and that the t losses would be very gradual and comparatively slight. s it follows that the solid and liquid portions combined ow greater proportionate losses during the shorter periods ıld be shown by the solid manure alone. These losses further increased by the greater activity of the bacteria in and liquid portions, which, being richer in moisture and ganic substances, offer a more favorable medium for their ent. An examination of the following tables will easily se contentions.

Loss Per Day of Ash.

Lot.	Length of Exposure. Days.	Solid. lbs.	Solid and Liquid. lbs.
1	131	.039	.027
2	70	.077	.059
3	76	.048	.059
4	50	.142	.285
5	61	.066	.116

Loss Per Day of Organic Matter.

1	131	.343	.270
2	70	.295	.355
3	76	.306	.362
4	50	.728	1.025
5	61	.557	.475

Loss Per Day of Nitrogen.

1	131	.008	.015
2	70	.010	.018
3	76	.007	.018
4	50	.021	.035
5	61	.017	.032

Loss Per Day of Phosphoric Acid.

1	131	.017	.012
2	70	.008	.005
3	76	.0·6	.019
4	50	.016	.022
5	61	.016	.021

Loss Per Day of Potash.

1	131	.009	.013
2	70	.002	.008
3	76	.009	.014
4	50	.007	.064
5	61	.012	.062

The daily losses of ash from the solid and the solid and liquid portions do not show great differences until we come to lots 4 and 5, where the differences are very considerable. Thus the daily loss of ash from lot 1 is .039 pounds in the solid, and .027 pounds in the solid and liquid, while in lot 4 the corresponding losses are .142 and .285 pounds, and in lot 5 they are .066 and .116 pounds. To a slighter extent, the same is true of the other constituents. It will be noticed, furthermore, that the daily losses from the solid manure of more volatile phosphoric acid and potash are rather uniform, irrespective of the length of the exposure. Thus the daily losses of phosphoric acid from lots 1, 3, 4 and 5 are .017, .016, .016 and .016 pounds, respectively. In the case of organic matter of the solid manures, the daily losses from lots 1, 2, 3, 4 and 5 are .343, .295, .306, .728 and .557 pounds, respectively. The same is true of the nitrogen. In all cases, the greatest average daily loss was from lot 4, whose exposure was shortest, and, with a few exceptions, the smallest average daily loss secured in lot 1, whose exposure was the longest. In lot 1 there was a greater daily loss of ash, organic matter and phosphoric acid from the solid portion than there was from the corresponding solid and liquid portion, and a smaller daily loss of nitrogen and potash from the solid portion than there was from the solid and liquid portion combined.

Description of the Experiment Plant.

A detailed description of the experiment plant will be found in he report for 1899,[1] but for the sake of clearness the diagram of he experiment is given here again.

[1] N. J. Sta. Rep., 1899, pp. 104-106.

Diagram of Experimen

Series. A

1. Check..
2. Minerals..
3. Manure, solid, fresh...............................
4. Manure, solid and liquid, fresh.................
5. Manure, solid, leached...........................
6. Manure, solid and liquid, leached............
7. Nitrate of soda, 5 gms...........................
8. Nitrate of soda, 10 gms..........................
9. Manure, solid, fresh; nitrate, 5 gms..... ...
10. Manure, solid, fresh; nitrate, 10 gms........
11. Manure, solid and liquid, fresh; nitrate, 5 gms.......... ....
12. Manure, solid and liquid, fresh; nitrate, 10 gms..
13. Manure, solid, leached; nitrate, 5 gms......
14. Manure, solid, leached; nitrate, 10 gms.....
15. Manure, solid and liquid, leached; nitrate, 5 gms..
16. Manure, solid and liquid, leached; nitrate, 10 gms..
17. Sulfate of ammonia................................
18. Dried blood... ....
19. Manure, solid, leached; sulfate of ammonia..
20. Manure, solid, leached; dried blood..........

Composition of the Manures Used.

The manures used in the fall of 1900 had the following compositions:

	Solid, Fresh.	Solid and Liquid, Fresh.	Solid, Leached.	Solid and Liquid, Leached.
	%	%	%	%
Water	84.339	85.228	78.135	77.864
Ash	2.207	2.101	4.022	4.727
Organic matter	13.454	12.671	17.843	17.409
Nitrogen, total	0.367	0.426	0.506	0.507
" soluble in water	0.042	0.150	0.037	0.090
" as nitrates	....	....	....	....
" as ammonia	0.039	0.095	0.008	0.013
" as soluble organic	0.003	0.055	0.029	0.077
" as insoluble organic	0.325	0.276	0.469	0.417
Phosphoric acid	0.349	02.44	0.418	0.498
Potash	0.279	0.260	0.191	0.801

Application of Manures and Fertilizers.

The manures and fertilizers were applied on October 3d, 1900. After careful weighing, the manure was thoroughly incorporated with the soil in the following manner: About one-half of the upper soil was first removed from the cylinder, the manure was placed in a tin pan, and a measured quantity of water poured over it, and stirred until the whole mass was in a semi-liquid state. The contents of the pan were then distributed uniformly over the exposed area, the consistency of the mass permitting a very even distribution. Such a procedure was more satisfactory than the old method of mixing the manure with the soil, for in the latter case the manure was distributed in the soil in lumps, in spite of the care taken to prevent this. After the addition of the manure, the soil that had been removed was again returned to the cylinder and the fertilizer was evenly distributed over the surface and the soil stirred.

Amounts Applied.

It was the aim to have the different kinds of manure applied uniformly in amount and slightly greater than would be used in ordinary practice, and corresponding with that frequently used in market

gardening. The application was in no case so excessive as to render the condition different from those obtaining in good farm practice, or at the rate of 16 tons per acre.

In the case of nitrogen in artificial forms, the nitrates only were applied in two different quantities, in the one case 5 grams per cylinder, equivalent to 160 pounds per acre, which may be regarded as a medium, and in the second, 10 grams per cylinder, equivalent to 320 pounds per acre, or a large application. This was done in order that the effect of denitrification, if any, might be more fully studied. In the case of ammonia and blood, an amount of nitrogen equivalent to that in the larger quantities of nitrate was used.

The Crops Grown.

The crop grown on the loam soils was wheat, and that was followed by timothy. The conditions under which the first crop was grown were somewhat different than those of the preceding years. The season was longer and included the winter months. Naturally, the temperature, the moisture and the chemical and biological conditions being different, gave rise to results not always concordant with those of the other seasons. In calculating the relative availability of the various forms of nitrogen, a serious difficulty was encountered, namely, the uncertainty as to the standard of comparison. The uniform yield from the parallel plots in previous seasons left little room for the misinterpretation of the results. It was merely necessary in most cases to take the average of the three plots in any one series, and subtracting from that the average yield on the blank plots, the yield due to the manure or fertilizer alone was obtained. Thus, by subtracting the average yield of series 2, the yield due to the 10 grams of sodium nitrate applied on series 8 was obtained. It was necessary to assume, of course, that the amount of nitrogen obtained from the soil itself by the crops on series 8 was equal in amount to the nitrogen obtained from the soil by the crops on series 2, where no nitrogen was applied. As a matter of fact, the average amount of nitrogen withdrawn from the soil itself on series 8 is never equal to, but always greater than, the average amount of nitrogen withdrawn from the soil on series 2. The reason for this is evident, if we consider that the soil nitrogen becomes soluble very gradually, and the thoroughness with which this soluble nitrogen is utilized by the growing crop depends on the root development of

the individual plants. It is quite apparent that the plants on series 2 will grow but slowly, since the amount of nitrogen placed at their disposal is very meagre. In consequence of this limited growth, the root development of the plants will be very limited, and, therefore, not capable of appropriating all or most of the nitrogen rendered soluble in the course of the season. On the other hand, the nitrate nitrogen offered to the plants on series 8 will make possible a good root development and a more thorough exploitation of the nitrogen derived from the soil itself. Moreover, the sodium nitrate will exert a solvent action on the soil humus over and above that exerted by the substances applied on series 2. Thus it will be seen that the average amount of nitrogen credited to the nitrate on series 8 will partly consist of the nitrogen derived from the soil in excess of the average amount derived from the soil of series 2. Since the soil nitrogen becomes soluble but slowly, the amount obtained by the growing crop will be directly proportional to the length of the growing season. Hence it follows that, everything being equal, the amount of nitrogen credited to nitrate will be greater for the long season than it would be for the short season. With these facts in mind, it will be easier to understand the data presented in the following tables, and also to account for apparently striking differences. Meanwhile, it should be added here that soil analyses of our other series, similarly treated, show that the soil of series 8 is actually poorer in nitrogen than is the soil of series 2. The claim of practical people that nitrates often exhaust the soil is thus not without foundation, for it has been shown that, starting with any given soil and cropping it for a series of years with application of nitrate, this soil will contain less nitrogen at the end of that period than a similar soil cropped without any applications of nitrogenous manures whatsoever. While this is in the main true, it does not at all detract from the value of nitrate as a source of nitrogen. Wagner says, with much justice, that such action of nitrate speaks in its favor rather than against it. After all, it is the object of the farmer to sell his soil nitrogen at as profitable a price as he can secure, and it is important that he shall be able to calculate with a reasonable amount of certainty just how much nitrogen his soil will yield to the growing crop within a given time. The solubility of nitrate renders it immediately available to the crop, and besides, it also helps the farmer to exploit his slowly available capital, the nitrogen of the humus. The modern practice of

manuring the crop rather than the soil is
sure, there are other things to be considered
of a soil with applications of nitrogen salt
nitrogen, leads to a gradual but steady decre
of the soil. Its physical properties bec
siderably, and these changes are more often t
farmer. In experimental work, a factor i
ders it more difficult to interpret the data
farmer has it in his power to employ mea
this tendency and will replace the organic
to the experimenter, he must make proper
his results from the soils variously treated.

In view of the lack of agreement in the
of series, it was deemed best to present the
and to present also the conclusions which o
the most plausible under the conditions of
same time, the other side is also presented,
ested may decide for themselves.

One hundred grains of wheat were plan
October 4th, 1900. One-quarter of the nit
was applied in the fall; all of the remaini
responding cylinders on April 11th, 1901, al
on cylinders 7, 9, 11, 13 and 15 on April 1
remaining nitrate on cylinders 8, 10, 12, 14
On May 2d, 1901, the portions of nitrate
plied on cylinders 8, 10, 12, 14 and 16.
applied in the fall in the manner alrea
germinated satisfactorily and the plants
May 1st a measurement of the plants in
undertaken, and showed that the plants on
more thrifty than those on series 1; the
were taller than those on series 5 and 6;
parent at that time between 7 and 8; the
taller than those in 9 and 10, and in all
13, 14, 15 and 16; 17 and 18 were about the
to both, with 20 more advanced than 19.
on July 3d, 1901, and analyzed in the la
straw being determined separately.

The Results of the Wheat Experiment, 1901.

accompanying table shows the actual dry matter both in aw and the grain from each series, the percentage of n found, the gain in nitrogen due to the materials added, percentage of the applied nitrogen recovered. In all cases gains in the different series are derived by subtracting the gain obtained on series 2, upon which minerals only were , from the average gain on that particular series.

application of nitrogen resulted in every case in a gain of tter over the series where none was applied. This corresponds e experience of the other seasons. The average amounts of tter and nitrogen from series 1, where nothing was applied, newhat less than those from series 2, where minerals only pplied. This indicates that the soil on series 1 is not only available nitrogen, but also deficient in one or more of the constituents. A comparative study of the yields from and 2 was presented in the report of 1901, and the data ed here can be compared with those already given.

as already stated, the seasonal conditions for this crop were t from those under which the other crops were grown, and ying the results obtained these facts should be borne in mind.

TABLE 1.

Results of the Wheat Experiment, 1901.

SERIES.		Nitrogen applied.	GRAIN.			STRAW.			TOTAL CROP.				Per cent. of nitrogen recovered.	Average per cent. of nitrogen recovered. Average of three.	Average per cent. Proximate average.
			Dry matter in crop.	Nitrogen in dry matter.	Nitrogen in crop.	Dry matter in crop.	Nitrogen in dry matter.	Nitrogen in crop.	Dry matter in crop.	Nitrogen in dry matter.	Nitrogen in crop.	Increase over check plot.			
		gms.	gms.	%	gms.	gms.	%	gms.	gms.	%	gms.	gms.			
1	A	....	35.5	1.727	0.613	55.1	0.402	0.222	90.6	0.922	0.835	....	....	....	....
	B	....	27.8	1.873	0.521	46.4	0.374	0.174	74.2	0.937	0.695	....	....	....	....
	C	....	49.5	1.727	0.855	75.4	0.272	0.205	124.9	0.848	1.060	....	....	....	....
2	A	....	40.2	1.709	0.687	57.3	0.299	0.171	97.5	0.880	0.858	....	....	....	....
	B	....	39.6	1.785	0.707	62.7	0.296	0.186	102.3	0.873	0.893	0.876	....	....	....
	C	....	65.8	1.549	1.019	112.4	0.242	0.272	178.2	0.724	*1.291	....	....	....	....
3	A	3.95	94.8	1.578	1.496	180.3	0.337	0.608	275.1	0.765	2.104	1.228	31.1	....	....
	B	....	121.8	1.493	1.818	196.3	0.314	0.616	318.1	0.765	2.434	1.558	39.4	33.3	30.2
	C	....	99.3	1.506	1.495	171.7	0.315	0.541	271.0	0.751	2.036	1.160	29.4	....	....
4	A	3.99	99.4	1.528	1.519	191.6	0.289	0.554	291.0	0.712	2.073	1.197	30.0	....	....
	B	....	121.3	1.524	1.849	220.9	0.322	0.711	342.2	0.748	2.560	1.684	42.2	34.0	29.9
	C	....	101.5	1.504	1.527	187.8	0.286	0.537	289.3	0.713	2.064	1.188	29.8	....	....
5	A	4.02	90.7	1.518	1.377	163.6	0.250	0.409	254.3	0.702	1.786	0.910	22.6	....	....
	B	....	129.2	1.690	2.183	196.5	0.226	0.444	325.7	0.807	2.627	*1.751	43.6	30.3	23.7
	C	....	97.4	1.543	1.503	165.3	0.225	0.372	262.7	0.714	1.875	0.999	24.9	....	....
6	A	3.88	87.1	1.547	1.347	143.4	0.241	0.346	230.5	0.734	1.693	0.817	21.1	....	....
	B	....	76.0	1.659	1.261	118.9	0.258	0.307	194.9	0.805	1.568	0.692	17.8	26.6	19.4
	C	....	124.7	1.585	1.976	209.3	0.234	0.490	334.0	0.737	2.466	*1.590	41.0	....	....
7	A	0.78	82.1	1.494	1.227	144.5	0.222	0.321	226.6	0.692	1.548	0.672	86.2	....	....
	B	....	118.3	1.579	1.868	199.6	0.234	0.467	317.9	0.735	2.335	*1.459	187.1	110.9	86.2
	C	....	69.5	1.513	1.052	118.4	0.242	0.287	187.9	0.713	1.339	0.463	59.4	....	....
8	A	1.55	129.2	1.606	2.077	210.0	0.298	0.626	339.2	0.797	2.703	1.827	117.9	....	....
	B	....	121.4	1.694	2.057	209.6	0.260	0.545	331.0	0.786	2.602	1.726	111.4	108.9	97.2
	C	....	119.5	1.597	1.908	197.6	0.240	0.474	317.1	0.751	2.382	1.506	97.2	....	....
9	A	4.78	134.0	1.496	2.005	238.8	0.242	0.578	372.8	0.693	2.583	1.707	36.1	....	....
	B	....	152.4	1.695	2.583	266.0	0.255	0.678	418.4	0.779	3.261	*2.385	50.4	40.7	40.7
	C	....	130.0	1.599	2.079	217.4	0.226	0.491	347.4	0.740	2.570	1.694	35.8	....	....
10	A	5.50	154.9	1.550	2.401	257.5	0.250	0.644	412.4	0.738	3.045	2.169	39.4	....	....
	B	....	196.6	1.866	3.669	297.3	0.274	0.815	493.9	0.908	4.484	*3.608	65.6	51.0	51.0
	C	....	181.5	1.607	2.917	290.1	0.285	0.605	471.6	0.747	3.522	2.646	48.1	....	....
11	A	4.77	144.6	1.570	2.270	268.8	0.274	0.737	413.4	....	3.007	2.181	44.7	....	....
	B	....	190.7	1.764	3.364	300.7	0.264	0.794	491.4	....	4.158	*3.282	68.8	49.6	40.1
	C	....	125.0	1.583	1.979	223.0	0.264	0.589	348.0	....	2.568	1.692	35.5	....	....
12	A	5.54	162.0	1.551	2.513	269.2	0.235	0.633	431.2	....	3.146	2.270	41.0	....	....
	B	....	167.9	1.655	2.779	289.2	0.264	0.763	457.1	....	3.542	2.666	48.1	44.7	44.7
	C	....	137.7	1.772	2.440	286.6	0.322	0.923	424.3	....	3.363	2.487	44.9	....	....
13	A	4.80	121.1	1.605	1.944	209.4	0.288	0.603	330.5	....	2.547	1.671	34.8	....	....
	B	....	125.8	1.657	2.085	216.4	0.272	0.589	342.2	....	2.674	1.798	37.5	38.0	38.0
	C	....	135.4	1.712	2.318	210.0	0.267	0.561	345.4	....	2.879	2.003	41.7	....	....
14	A	5.57	148.4	1.602	2.377	252.0	0.242	0.614	400.4	....	2.991	2.115	38.0	....	....
	B	....	171.0	1.733	2.963	263.4	0.269	0.709	434.4	....	3.672	2.796	50.2	43.5	43.5
	C	....	153.9	1.661	2.556	238.0	0.285	0.728	391.9	....	3.284	2.358	42.3	....	....
15	A	4.66	126.1	1.504	1.897	201.6	0.240	0.484	327.7	....	2.381	1.505	32.3	....	....
	B	....	126.8	1.603	2.033	207.4	0.258	0.535	334.2	....	2.568	1.692	36.3	30.5	30.5
	C	....	95.6	1.573	1.504	169.1	0.260	0.440	264.7	....	1.944	1.068	22.9	....	....
16	A	5.43	171.6	1.622	2.783	276.9	0.255	0.706	448.5	....	3.489	2.613	48.1	....	....
	B	....	175.3	1.762	3.089	281.7	0.264	0.744	457.0	....	3.833	2.957	54.5	39.0	39.0
	C	....	136.5	1.496	2.042	236.1	0.258	0.609	372.6	....	2.651	*1.775	32.7	....	....
17	A	1.62	108.8	1.615	1.757	189.9	0.252	0.479	298.7	....	2.236	1.360	84.0	....	....
	B	....	120.5	1.628	1.962	179.5	0.234	0.420	300.0	....	2.382	1.506	93.0	77.7	88.5
	C	....	96.0	1.438	1.380	161.6	0.250	0.404	257.6	....	1.784	*0.908	56.0	....	....
18	A	1.55	102.8	1.617	1.662	173.3	0.289	0.414	276.1	....	2.076	1.200	77.4	....	....
	B	....	94.4	1.692	1.597	145.0	0.249	0.361	249.4	....	1.958	1.082	69.8	91.4	73.6
	C	....	166.5	1.517	2.526	125.0	0.254	0.318	291.5	....	2.844	*1.968	127.0	....	....
19	A	5.64	145.2	1.636	2.375	243.8	0.235	0.573	389.0	....	2.948	2.072	36.7	....	....
	B	....	149.5	1.613	2.411	237.0	0.291	0.690	386.5	....	3.101	2.225	39.4	39.1	39.1
	C	....	156.3	1.670	2.610	238.9	0.250	0.597	395.2	....	3.207	2.331	41.3	....	....
20	A	5.57	108.8	1.572	1.710	190.7	0.244	0.465	299.5	....	2.175	1.299	23.3	....	....
	B	....	122.4	1.535	1.879	205.4	0.233	0.479	327.8	....	2.358	1.482	26.6	25.9	25.9
	C	....	117.6	1.637	1.925	206.0	0.239	0.492	323.6	....	2.417	1.541	27.7	....	....

* Not included in the average.

TABLE A.

Average Amount of Dry Matter in Crop, 1901.

Average of Two Marked with an *.

Grain.	Series.	Straw.	Series.	Proportion of Grain to Straw.
31.1 gr.*	1	50.7 gr.*	1	1:1.63
39.9 “ *	2	60.0 “ *	2	1:1.50
97.0 “ *	3	176.0 “ *	3	1:1.81
100.4 “ *	4	189.7 “ *	4	1:1:89
94.0 “ *	5	164.4 “ *	5	1:1.75
81 5 “ *	6	131.1 “ *	6	1:1.61
75.7 “ *	7	131.4 “ *	7	1:1.74
123.4 “	8	205.4 “	8	1:1.66
132.0 “ *	9	228.1 “ *	9	1:1.73
168.2 “ *	10	273.8 “ *	10	1:1.63
134.8 “ *	11	245.9 “ *	11	1:1.78
155.9 “	12	281.7 “	12	1:1.81
127.4 “	13	211.9 “	13	1:1.66
151.1 “ *	14	245.0 “ *	14	1:1.62
126.4 “ *	15	204.5 “ *	15	1:1.62
173.4 “ *	16	279.3 “ *	16	1:1.61
114.6 “ *	17	184.7 “ *	17	1:1.62
98.6 “ *	18	159.1 “ *	18	1:1.61
150.3 “	19	239.9 “	19	1:1.59
120.0 “ *	20	205.7 “ *	20	1:1.71

Average of Three in Each Case.

Grain.	Series.	Straw.	Proportion of Grain to Straw.
37.6 gr.	1	58.9 gr.	1:1.56
48.5 “	2	77.5 “	1:1.59
105.3 “	3	182.8 “	1:1.73
107.4 “	4	200.1 “	1:1.86
105.7 “	5	175.1 “	1:1.65
95.9 “	6	157.2 “	1:1.64
89.9 “	7	154.2 “	1:1.72
123.4 “	8	205.4 “	1:1.66
138.8 “	9	241.1 “	1:1.74
177.7 “	10	281.6 “	1:1.59
153.1 “	11	264 2 “	1:1.72
155.9 “	12	281.7 “	1:1.81
127.4 “	13	211.9 “	1:1.66
157.8 “	14	251.1 “	1:1.59
116.2 “	15	192.7 “	1:1.66
161.1 “	16	264.9 “	1:1.64
108.4 “	17	177.0 “	1:1.63
121.2 “	18	147.8 “	1:1.22
150.3 “	19	239.9 “	1:1.59
116.3 “	20	200.7 “	1:1.81

The figures show that more dry matter, both as grain and straw, were produced on 2 than there was on 1. While more dry matter was produced on 4, where solid and liquid fresh was applied, than there was on 3, where solid fresh alone was applied, there was a greater yield of dry matter, both as grain and straw, on 5, where solid leached was applied, than there was on 6, where solid and liquid leached was applied. Similarly, there was a greater yield of dry matter from series 8, 10, 12, 14 and 16 than there was from the corresponding odd series of 7, 9, 11, 13 and 15. This is as should be expected, for each of the five even series received 5 grams more of sodium nitrate than the preceding odd series. The results are not at all equivocal, and show that where greater absolute amounts of nitrogen were applied, greater absolute amounts of dry matter were harvested, and that without exception. The nitrogen applied in the form of ammonia, both alone or together, with solid leached manure, gave greater returns of dry matter than was produced on the corresponding series, where the nitrogen was applied as dried blood. Similarly, the double quantity of nitrate nitrogen, alone as well as together with solid manure leached, gave greater returns of dry matter than the corresponding, where ammonia nitrogen was used.

The proportion of the grain to the straw seems to be fairly constant. In 3 and 4 there is a wider ratio than in the other cases, indicating that there was some forcing action and more rank growth. It appears, also, that in most cases there is a narrower ratio where the double quantity of nitrate was used as against the single portion. The solid manure fresh shows a narrower ratio than the solid and liquid fresh, when used either with the single or double quantity of nitrate, or when used alone. The solid leached shows a wider ratio than the solid and liquid leached, either when used alone or with the single or double quantity of nitrate. The fresh manures, both solid and solid and liquid, show, with hardly an exception, a wider ratio than the leached manures. In other words, in every pound of dry matter produced on the series where the leached manures were applied, there is more grain than there is in a similar quantity of dry matter obtained from the series where the fresh manures were used. But the absolute quantity of dry matter was greater, on the average, on the series where the fresh manures were used.

TABLE B.

Average Per Cent. of Nitrogen in the Dry Matter.

Average of Two Marked with an *.

Grain.	Series.	Straw.	Series.	Total Crop.
1.81 %.*	1	.39 %.*	1	.93 %.*
1.75 " *	2	.30 " *	2	.88 " *
1.54 " *	3	.33 " *	3	.76 " *
1.52 " *	4	.29 " *	4	.71 " *
1.53 " *	5	.24 " *	5	.71 " *
1.59 " *	6	.25 " *	6	.77 " *
1.50 " *	7	.23 " *	7	.69 " *
1.63 "	8	.27 "	8	.78 "
1.55 " *	9	.23 " *	9	.72 " *
1.58 " *	10	.23 " *	10	.75 " *
1.58 " *	11	.27 " *	11	.73 " *
1.65 "	12	.27 "	12	.77 "
1.66 "	13	.28 "	13	.79 "
1.63 " *	14	.26 " *	14	.79 " *
1.55 " *	15	.25 " *	15	.75 " *
1.69 " *	16	.26 " *	16	.81 " *
1.62 " *	17	.24 " *	17	.77 " *
1.65 " *	18	.24 " *	18	.77 " *
1.64 "	19	.26 "	19	.79 "
1.58 " *	20	.24 " *	20	.73 " *

The Average Per Cent. of Nitrogen.

Average of Three.

Grain.	Series.	Straw.	Series.	Total Crop.
1.76 %.	1	.34 %.	1	.88 %.
1.66 "	2	.27 "	2	.80 "
1.52 "	3	.32 "	3	.76 "
1.52 "	4	.30 "	4	.73 "
1.59 "	5	.23 "	5	.74 "
1.59 "	6	.24 "	6	.75 "
1.54 "	7	.23 "	7	.71 "
1.63 "	8	.27 "	8	.78 "
1.60 "	9	.24 "	9	.74 "
1.68 "	10	.24 "	10	.80 "
1.65 "	11	.27 "	11	.78 "
1.65 "	12	.27 "	12	.77 "
1.66 "	13	.28 "	13	.79 "
1.67 "	14	.27 "	14	.81 "
1.56 "	15	.25 "	15	.74 "
1.64 "	16	.26 "	16	.78 "
1.57 "	17	.24 "	17	.75 "
1.59 "	18	.25 "	18	.84 "
1.64 "	19	.26 "	19	.79 "
1.58 "	20	.23 "	20	.73 "

The above table shows that the dry matter of series 1 is considerably richer in nitrogen than the dry matter from any of the other series, although the *absolute* amount of nitrogen produced from series 1 is very small. Comparing the solid manure fresh, and the solid and liquid fresh, we find that the former has produced dry matter relatively richer in nitrogen than the latter.

In the case of 5 and 6, where solid leached and solid and liquid leached were used respectively, the relation is reversed, the latter showing a proportionately higher content of nitrogen in its dry matter. Series 8, with the double quantity of nitrate, has produced dry matter relatively richer in nitrogen than series 7, where the single portion was used. These relations hold good throughout the even series, 10, 12, 14 and 16, with the double portion of nitrate and the corresponding manures, showing, in practically every case, a proportionately higher content of nitrogen in their dry matter than is true of the odd series, 9, 11, 13 and 15, where the single quantity of nitrate and the corresponding manures were used. These remarks apply to the first of the two tables, where the average of two only was taken in most cases. Nevertheless, they can be applied in a general way, also, to the second table.

TABLE C.

Average Amount of Nitrogen in Crop, 1901.

Average of Two Marked with an *.

Series.	Grain.	Straw.	Total Crop.	Proportion of Grain to Straw.
1.................	.567 gr.*	.198 gr.*	.765 gr.*	1: .35
2.................	.697 " *	.178 " *	.875 " *	1: .28
3.................	1.495 " *	.574 " *	2.070 " *	1: .38
4.................	1.523 " *	.545 " *	2.068 " *	1: .36
5.................	1.440 " *	.390 " *	1.830 " *	1: .27
6.................	1.304 " *	.326 " *	1.630 " *	1: .25
7.................	1.139 " *	.304 " *	1.443 " *	1: .27
8.................	2.014 "	.548 "	2.562 "	1: .27
9.................	2.042 " *	.534 " *	2.576 " *	1: .26
10.................	2.659 " *	.624 " *	3.283 " *	1: .23
11.................	2.124 " *	.663 " *	2.787 " *	1: .32
12.................	2.574 "	.773 "	3.350 "	1: .30
13.................	2.116 "	.584 "	2.700 "	1: .28
14.................	2.466 " *	.646 " *	3.112 " *	1: .26
15.................	1.965 " *	.509 " *	2.474 " *	1: .26
16.................	2.936 " *	.725 " *	3.661 " *	1: .25
17.................	1.859 " *	.449 " *	2.309 " *	1: .24
18.................	1.629 " *	.387 " *	2.017 " *	1: .24
19.................	2.465 "	.620 "	3.085 "	1: .25
20.................	1.902 " *	.485 " *	2.387 " *	1: .25

Average Amount of Nitrogen in Crop.

Average of Three.

Series.	Grain.	Straw.	Total Crop.	Proportion of Grain to Straw.
1.................	.663 gr.	.200 gr.	.853 gr.	1: .32
2.................	.804 "	.209 "	1.014 "	1: .26
3.................	1.603 "	.588 "	2.191 "	1: .37
4.................	1.632 "	.601 "	2.232 "	1: .37
5.................	1.688 "	.408 "	2.096 "	1: .24
6.................	1.528 "	.381 "	1.909 "	1: .25
7.................	1.382 "	.358 "	1.741 "	1: .26
8.................	2.014 "	.548 "	2.562 "	1: .27
9.................	2.222 "	.582 "	2.805 "	1: .26
10.................	2.996 "	.688 "	3.684 "	1: .23
11.................	2.538 "	.707 "	3.244 "	1: .28
12.................	2.574 "	.773 "	3.350 "	1: .30
13.................	2.116 "	.584 "	2.700 "	1: .28
14.................	2.632 "	.667 "	3.299 "	1: .25
15.................	1.811 "	.486 "	2.298 "	1: .27
16.................	2.638 "	.686 "	3.328 "	1: .26
17.................	1.699 "	.434 "	2.134 "	1: .26
18.................	1.928 "	.364 "	2.293 "	1: .19
19	2.465 "	.620 "	3.085 "	1: .25
20.................	1.838 "	.479 "	2.313 "	1: .26

The above tabulations show the average amount of nitrogen in the grain from each series, the average amount of nitrogen in the straw from each series, the average total amount of nitrogen from each series, and the proportion of the nitrogen in the grain and straw of each series. From Table A it can be seen that the yield of dry matter in the straw was greater than the yield of dry matter in the grain. On the other hand, Tables B and C show that both relatively and absolutely a greater amount of nitrogen was obtained in the grain than there was in the straw. While but few grains were produced on series 1, nevertheless, these were well formed. The ratio of grain to straw is somewhat wider here than in most of the other cases, but is not as wide as it is in series 3 and 4. The absolute amount of nitrogen, both in the grain and in the straw, is greater on series 2 than it is on series 1. An explanation of these differences was attempted in the Report for 1901. It is sufficient to state here that the minerals applied on series 2 help to make soluble the inert soil nitrogen, and for this reason the crop on this series finds more nitrogen available than does the crop on series 1, where nothing is applied. Moreover, it is very probable that on series 1 there is lack of one or more of the mineral constituents. The absolute amounts of nitrogen obtained from series 3 and 4 are about equal, showing that through the longer season of growth the solid manure fresh furnished as much nitrogen as the solid and liquid fresh. However, there was obtained somewhat more nitrogen in the grain and somewhat less nitrogen in the straw on series 4 than there was on series 3. Series 5 and 6, where the leached manures were applied, gave a smaller yield of nitrogen than the fresh manures on series 3 and 4. The solid manure leached on series 5 gave a greater return of nitrogen, both in the grain and in the straw, than the solid and liquid leached on series 6. As would be expected, there was a greater return of nitrogen from series 8, where 10 grams of sodium nitrate were applied, than there was from series 7, where only 5 grams of sodium nitrate were applied. In series 8, 10, 12, 14 and 16, where 10 grams of sodium nitrate were applied, together with the corresponding manures, there was a greater return of nitrogen than there was from the odd series, 7, 9, 11, 13 and 15, where only 5 grams of sodium nitrate were applied, together with the corresponding manures. In series 9, with the solid manure fresh and 5 grams of sodium nitrate, there was a slightly greater return than there was

from series 11, where the same amount of nitrogen was applied in the form of solid and liquid manure fresh, together with the 5 grams of sodium nitrate. The same is true of 10 and 12, to each of which 10 grams of sodium nitrate were applied, besides the manure, which was solid fresh in 10 and solid and liquid fresh in series 12. This would indicate that more nitrogen was obtained by the crop from the solid manure alone than there was from the solid and liquid when applied together. In series 13 a greater amount of nitrogen was returned in the crop than there was on series 15, showing in this case the superiority of the solid leached over the solid and liquid leached. On the other hand, a greater amount of nitrogen was returned from series 16 than there was from series 14, which is in favor of the solid and liquid leached. On the whole, the fresh manures have returned greater amounts of nitrogen in the crop than was returned by the leached manures. This is in accord with previous experience, and shows the greater availability of the fresh manures. The nitrogen in ammonium sulphate made greater returns in the crop, when used either alone or together with solid leached, than was returned by the corresponding series where dried blood was used. The proportion of the nitrogen in the grain to that in the straw is, on the whole, rather constant. The fresh manures, where used alone, caused a more rank growth, and as a result there was more straw and more nitrogen in the straw in proportion to the grain on those series. Series 5, 6, 7, 8, 9, 13, 14, 15, 16, 19 and 20 show about the same proportion of nitrogen in grain and straw. In series 11 and 12, with the double quantity of nitrate and the corresponding fresh manures, there was a more rank growth and a wider proportion. In series 9, 17 and 18 the proportion was narrower, particularly in series 9.

THE AVAILABILITY OF THE NITROGEN IN THE SOLID AND IN THE SOLID AND LIQUID MANURE, FRESH.

In determining the availability of the different substances applied, it is necessary, of course, to use a standard of comparison. In these experiments the amount of nitrogen recovered from series 8 is taken as the standard of comparison, with the value of 100, and the amounts recovered from the other soils are measured according to this scale. The interpretation of the data obtained this year presents

greater difficulties than were met with eith
for the conditions of growth were different
place, the character of the season was differe
planted in October and the crop harvested
During the winter a number of cylinders h
masses of ice and snow, which undoubtedly i
For this reason it becomes necessary to dis
whose yields looked suspicious. In Table D
recovered from the different cylinders. C
averages of three from each series, column 2
the suspicious cases have been eliminated, c
recovery according to column 2, and column
gen, *not* recovered, also according to column
here in order to enable the reader to judge
our deductions have been warranted.

It will be noticed that unlike the yields
yield from the solid fresh, and the yield fr
fresh, on series 3 and 4, respectively, do n
other hand, in the other seasons the solid a
taken together, showed marked superiorit
alone.* Thus there was recovered in the w
the solid manure fresh, and 29.9 per cent. f
fresh, amounts practically identical. In th
responding figures were 8.3 per cent. and 40.
and in the oat crop of 1900 the correspon
per cent. and 30.60 per cent., respectively.
that through the long season the solid ma
efficacious as the solid and liquid fresh.

THE AVAILABILITY OF THE NITRO AND IN THE SOLID AND LIQU

In former seasons the recovery from th
was much less than that from the solid an
in 1899 the figures were 8.4 per cent. for the
per cent. for the solid and liquid leached
were 7.38 and 22.06 per cent., respectively.

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*See N. J. Sta. Rep., 1901, p. 164.

was 23.7 per cent. for the solid leached, and 19.4 per cent. solid and liquid leached, showing, if anything, in favor of d leached. It will be noticed that the solid fresh proved to the solid leached, and the solid and liquid fresh superior olid and liquid leached. Also, in this case, the longer season th has enabled the crop to obtain a greater proportion of ly-available nitrogen contained in the solid portion.

RELATIVE AVAILABILITY OF THE NITROGEN IN THE FORM OF NITRATE, AMMONIA AND OF ORGANIC MATTER IN DRIED BLOOD.

the other years, the nitrogen in the form of nitrate on gave a greater return than series 17, where ammonium was used, and series 18 where dried blood was used. The nitrogen in the dried blood made a better showing than in r seasons. Thus, in 1899 the recovery from the dried blood t per cent., and in 1900, 52.15 per cent., as against 73.6 per 1901. It should be borne in mind, however, that part of ogen, which is here credited to the nitrate, ammonia or dried really derived from the soil, since with the nitrogen applied ts on these series were enabled to secure more nitrogen from itself than did the plants on series 2.

FFECT OF THE USE OF THE SOLID AND OF THE LID AND LIQUID PORTIONS OF COW MANURE, FRESH AND LEACHED, WITH NITROGEN IN THE FORM OF NITRATE, OF AMMONIA AND OF ORGANIC MATTER.

bject of these combinations was to study the availability of erent nitrogenous substances, when used together, as well as It was, moreover, intended to determine whether the manure ead to denitrification when applied together with nitrate. revious years, the clear manure, free from any admixture of as used, and the amount of manure applied was in no case than that applied in actual practice. This season's ex- tends to confirm the earlier results in many respects. As ther cases, the nitrogen in the different combinations showed,

in a number of instances, greater efficiency than where these forms were used singly. The reason for this we must seek in the fact that no single form is so well adapted to nourish the plant continually and uniformly as are the proper combinations. Such uniform feeding not only enables a uniform and healthy growth, but it also makes possible a more thorough utilization of the plant-food made available by providing a better root system. Moreover, the nitrogen salts applied would of themselves help to make soluble the organic matter, while the organic portion would improve the physical condition of the soil. These considerations would explain why, in many instances, the calculated recovery is less than the actual recovery. The influence of the season itself has been discussed elsewhere and need not be considered here.

Th difference between the per cent. of nitrogen actually recovered and the per cent. recoverable, calculated, represents the losses due to all causes; the difference is expressed in percentage in the last column of Table D. The per cent. recovered is greater in every case where the double quantity of nitrate was used with the corresponding manures than is true of the series where the single quantity of nitrate and the corresponding manures were used. The recovery in 9 is about the same as it is in 11, showing no superiority of the solid fresh over the solid and liquid fresh when used together with the single quantity of nitrate. On the other hand, series 10 shows a greater recovery than series 12, and in this case the double quantity of nitrate, when used together with the solid fresh, gave better returns than the double quantity of nitrate used together with the solid and liquid fresh. In the leached manures, where used singly, the solid portion showed a greater recovery than the solid and liquid portion when used together. Similarly, where the leached manures were used together with nitrate, the solid portions gave better returns than the solid and liquid portion. Thus, in series 13 the recovery was 38.0 per cent., as compared with 30.5 per cent. in series 15, and in series 14 it was 43.5 per cent., as against 39.0 per cent. in series 16.

TABLE D.

Wheat—1901.

	Average of Three.	Nitrogen Recovered. Proximate Average.	Calculated Recovery.	Nitrogen not Recovered.
	%	%	%	%
	33.3	30.2	......	......
	34.0	29.9	......	......
	30.3	23.7	......	......
	26.6	19.4	......	......
	110.9	86.2	......	......
	108.9	97.2	......	......
	40.7	40.7	39.4	......
	51.0	51.0	49.1	......
	49.6	40.1	39.1	......
	44.7	44.7	48.7	8.3
	38.0	38.0	33.9	......
	43.5	43.5	44.1	1.5
	30.5	30.5	30.6	......
	39.0	39.0	41.3	5.4
	77.7	88.5	......	......
	91.4	73.6	......	......
	39.1	39.1	39.2	......
	25.9	25.9	37.6	31.2

ctual recovery exceeds the calculated recovery in four cases n; and namely, in series 9, 10, 11 and 13. The actual re- practically the same as the calculated recovery in series 14, 9. In series 12, 16 and 20 the calculated recovery is greater actual recovery, and of these only 20 show a considerable e. For the sake of comparison, the relative availability of rent substances, as found for the several seasons, are again here, together with the results for 1901:

	Corn. 1898.	Oats. 1899.	Oats and Millet. 1899.	Oats. 1900.	Oats and Corn. 1900.	Wheat. 1901.
oda	100	100	100	100	100	100
f ammonia	99.5	72.9	77.9	99.22	87.75	91.0
l	95.4	58.5	61.3	68.85	73.07	75.7
re, fresh	16.76	12.0	43.1	14.16	26.36	31.1
re, leached	37.87	12.1	46.4	9.67	21.99	24.4
iquid fresh	49.66	58.2	88.4	40.10	51.46	30.8
iquid, leached	50.38	20.0	33.0	28.91	35.91	19.9

The relative availability of the nitrogen in the ammonium sulphate and dried blood, while high, does not differ very much from the figures obtained at other times. The relation of the solid to the solid and liquid manures is reversed in 1901, the availability of the first being greater than the availability of the second.

The Experiment with Cabbage, 1901.

This experiment was carried on in cylinders similar to those used in the experiments heretofore described, except that the soil used here was not a heavy loam, as in the other cases, but a sandy loam derived from the former by the addition of an equal portion of sand by weight. These sandy loams are located on the same experiment plot, and they have been treated, as regards manuring and moisture conditions, in the same manner as the others. Their crops were, however, different. On the heavy soils, corn, oats, wheat and timothy were grown, crops adapted to such soils; on the lighter soils, tomatoes, potatoes and sweet potatoes were grown, in order to study these soils in connection with the crops best adapted to them. While the results obtained on the heavier soils have been published yearly since 1899, it was deemed advisable for various reasons to withhold from publication the results obtained on the lighter soils. It was decided to publish the data presented here, together with the results obtained in the analytical study of the different soils, so as to bring out more clearly the mutual relation between the crop and the soil.

The Manures Used.

The several manures employed here were of the following composition:

	Solid, Fresh. %	Solid and Liquid, Fresh. %	Solid, Leached. %	Solid and Liquid, Leached. %
Water	83.488	90.801	81.744	87.614
Ash	2.410	1.734	4.550	2.545
Organic matter	14.102	7.465	13.706	9.841
Nitrogen, total	0.384	0.494	0.416	0.341
" soluble in water	0.048	0.320	0.062	0.122
" as nitrates	....	....	Trace.	....
" as ammonia	0.035	0.046	0.039	0.009
" as soluble organic	0.013	0.274	0.023	0.113
" as insoluble organic	0.336	0.174	0.354	0.219
Phosphoric acid	0.394	0.219	0.433	0.384
Potash	0.224	0.376	0.301	0.507

The manures and fertilizers were applied on August 1st, 1901. The solid fresh contained 4.03 grams of nitrogen and the solid and liquid fresh 4.06 grams of nitrogen, the solid leached 4.01 grams of nitrogen and the solid and liquid leached 3.96 grams of nitrogen. All of the ammonium sulphate and dried blood were applied on the corresponding cylinders, and 5 grams of sodium nitrate each on the corresponding cylinders. On September 2d 5 grams additional of sodium nitrate were applied on 8, 10, 12, 14 and 16, making 10 grams in all for each of these cylinders. Four vigorous plants were set out in each cylinder and made satisfactory progress for a while. It was soon noticed, however, that many of the plants were affected with club-root, and these were pulled up until in some cylinders but one plant remained. It was feared that the experimental results would be strongly vitiated because of this circumstance, but the analytical data showed that the plant-food in the different cylinders was utilized by the unequal number of plants more evenly than was expected.

The accompanying table shows the dry matter in the different crops, the percentage of nitrogen contained in them, the gain in nitrogen due to the materials added, and the percentage of the applied nitrogen recovered. In all cases the net gains in the different series are derived by subtracting the average gain obtained on series 2, upon which minerals only were applied, from the average gain for that particular series.

TABLE 2.

Results of the Cabbage Experiment, 1901.

SERIES.		Nitrogen applied.	Air-dry matter in crop.	Nitrogen in air-dry matter.	Nitrogen in crop.	Increase over check plot.	Per cent. of nitrogen recovered.	Average per cent. of nitrogen recovered.
		gms.	gms.	%	gms.	gms.		
1	A	....	49.	1.533	0.751	....	....	....
	B	....	72.	1.224	0.879	....	....	....
	C	....	74.	1.247	0.923	....	....	....
2	A	....	67.	1.438	0.963	....	....	....
	B	....	67.	1.263	0.846	*0.896	....	....
	C	....	82.	1.073	0.880	....	....	....
3	A	4.08	98.	1.581	1.549	0.653	16.2	
	B	....	159.	1.247	1.963	1.067	27.6	21.6
	C	....	100.	1.796	1.796	0.900	22.3	
4	A	4.06	205.	1.367	2.802	1.906	46.9	
	B	....	158.	1.454	2.300	1.404	34.6	42.4
	C	....	211.	1.303	2.749	1.853	45.7	
5	A	4.01	123.	1.462	1.798	0.902	22.5	
	B	....	138.	1.279	1.765	0.869	21.7	22.0
	C	....	138.	1.279	1.765	0.869	21.7	
6	A	3.96	139.	1.351	1.878	0.982	24.8	
	B	....	174.	1.208	2.102	1.206	30.5	28.9
	C	....	174.	1.232	2.144	1.248	31.5	
7	A	0.78	124.	1.041	1.291	0.395	50.6	
	B	....	117.	1.128	1.320	0.424	54.4	49.9
	C	....	108.	1.152	1.244	0.348	44.6	
8	A	1.55	155.	1.096	1.699	0.803	51.8	
	B	....	138.	1.096	1.512	*0.616	39.7	60.1
	C	....	151.	1.295	1.955	1.059	68.3	
9	A	4.81	172.	1.430	2.460	1.564	32.5	
	B	....	210.	1.192	2.503	1.607	33.4	35.0
	C	....	185.	1.502	2.779	1.883	39.1	
10	A	5.58	159.	1.526	2.426	1.530	27.4	
	B	....	208.	1.438	2.991	2.095	37.5	32.5
	C	....	105.	1.875	1.969	*1.073	19.2	
11	A	4.84	159.	1.875	2.981	2.085	43.1	
	B	....	240.	1.438	3.451	2.555	52.8	51.6
	C	....	258.	1.454	3.751	2.855	59.0	
12	A	5.61	245.	1.578	3.854	2.958	52.7	
	B	....	204.	1.668	3.403	2.507	44.7	52.2
	C	....	278.	1.518	4.220	3.324	59.3	
13	A	4.79	179.	1.282	2.304	1.408	27.3	
	B	....	145.	1.430	2.074	1.178	24.6	27.3
	C	....	185.	1.271	2.331	1.435	30.0	
14	A	5.56	167.	1.406	2.348	1.452	26.1	
	B	....	184.	1.438	2.646	1.750	31.5	28.8
	C	....	190.	1.311	2.491	1.595	28.7	
15	A	4.74	197.	1.208	2.380	1.484	31.3	
	B	....	155.	1.335	2.069	1.173	24.7	29.6
	C	....	157.	1.557	2.444	1.548	32.7	
16	A	5.51	183.	1.422	2.602	1.706	31.0	
	B	....	192.	1.502	2.884	1.988	36.1	31.6
	C	....	140.	1.732	2.425	1.529	27.8	
17	A	1.62	135.	1.303	1.759	0.863	53.3	
	B	....	122.	1.517	1.851	0.955	59.0	57.0
	C	....	147.	1.255	1.845	0.949	58.6	
18	A	1.55	124.	1.422	1.763	0.867	55.9	
	B	....	128.	1.367	1.750	0.854	55.1	56.9
	C	....	131.	1.390	1.821	0.925	59.7	
19	A	5.63	165.	1.470	2.426	1.530	27.2	
	B	....	155.	1.510	2.341	1.445	25.7	28.9
	C	....	215.	1.303	2.801	1.905	33.8	
20	A	5.56	150.	1.637	2.456	1.560	28.1	
	B	....	132.	1.422	1.877	*0.981	17.6	26.7
	C	....	194.	1.446	2.805	1.909	34.3	

* Not included in the average.

TABLE E.

verage Amount of Dry Matter in Crop, and the Average Per Cent. of Nitrogen.

ies.	Dry Matter. gr.	Nitrogen. %
1	65	1.31
2	72	1.25
3	119	1.47
4	191	1.36
5	133	1.34
6	162	1.26
7	116	1.11
8	153	1.19
9	189	1.37
0	183	1.47
1	249	1.44
2	242	1.58
3	169	1.30
4	180	1.39
5	169	1.36
6	172	1.53
7	135	1.35
8	128	1.39
9	178	1.47
0	172	1.53

e tabulations show that the results obtained from the lighter e similar to those from the heavier soils. It will be noticed ries 1 has produced less dry matter than series 2, but that ative content of nitrogen is greater than it is in series 2. The anure fresh has produced less dry matter than series 4, where id and liquid fresh was used, and the solid manure leached, es 5, has produced less dry matter than series 6, where the nd liquid fresh was used. On the other hand, the percentage ogen in the dry matter from series 3 is higher than it is in matter from series 4; and the dry matter from series 5 has er percentage of nitrogen than the dry matter from series 6. even series, 8, 10, 12, 14 and 16, with the double quantity ate, either with manure or without it, there was a greater f dry matter than in the corresponding odd series, 7, 9, 11, 15. The percentage of nitrogen in the dry matter from en series is also higher in every case than it is in the dry matter he corresponding odd series. Similarly, the solid and liquid

fresh, having given a greater return of dry matter than the solid fresh, retains the same relation when it is used together with nitrate. Thus, we find that there is a greater yield of dry matter from series 11 than there is from series 9, and a greater yield of dry matter from series 12 than there is from series 10. In series 6, where the solid and liquid leached was used alone, there was a greater return of dry matter than there was from series where the solid leached was used alone. When these are used together with nitrate, the same relations do not hold good, for we find that in series 15 there was no more dry matter produced than there was in series 13, and in series 16 there was even less dry matter produced than there was in series 14. Series 17, where the ammonium sulphate was used, gave a greater return of nitrogen than did series 18, where dried blood was applied. Similarly, in series 19, where the ammonium sulphate was used together with solid manure leached, there was a greater return of dry matter than there was in series 20, where dried blood and solid manure leached were used together. It will also be seen that the fresh manures have produced, on the average, considerably more dry matter than was produced by the leached manures, and the average percentage of nitrogen in the dry matter is also higher in the former than it is in the latter. This fact is perfectly in accord with the accumulated data of several years. The percentage of nitrogen in the dry matter from series 18 is higher than that in the dry matter from series 17, and the same relations hold good in the case of series 19 and 20, respectively.

TABLE F.

The Absolute Amount of Nitrogen in the Dry Matter.

Series.	Nitrogen. gr.	Series.	Nitrogen. gr.
1	.851	11	3.601
2	.896	12	3.826
3	1.776	13	2.203
4	2.617	14	2.495
5	1.776	15	2.298
6	2.041	16	2.638
7	1.285	17	1.818
8	1.827	18	1.778
9	2.581	19	2.523
10	2.708	20	2.630

In considering the nitrogen yield in the crop from the different series, we find that there was a greater absolute amount of nitrogen contained in the dry matter from series 2 than there was in that from series 1. The solid and liquid manure fresh gave a greater return than did the solid fresh; and the solid and liquid leached gave a greater return than did the solid leached. The same relations hold good, also, in the combinations, for we find that series 11 gave a greater return than series 9, and series 12 gave a greater return than series 10. Similarly, series 15 gave a somewhat greater return than series 13, and series 16 gave a greater return than did series 14. It will be seen, therefore, that while these relations hold good, the superiority of the solid and liquid fresh over the solid fresh is even greater in combination than when they are used alone; on the other hand, the superiority of the solid and liquid leached over the solid leached is less pronounced in the combinations than it is when they are used alone. In every case there was a greater return of nitrogen in the even series, 10, 12, 14 and 16, than there was from the corresponding odd series, 7, 11, 13 and 15. Series 17 gave a greater return than did series 18; on the other hand, series 20 gave a greater return than did series 19.

THE AVAILABILITY OF THE NITROGEN IN THE SOLID AND IN THE SOLID AND LIQUID PORTIONS OF THE FRESH AND LEACHED MANURES.

Table G shows that the recovery from the solid and liquid fresh was greater in every case than the recovery from the solid fresh, a fact perfectly in accord with previous experience. Similarly, the recovery from the solid and liquid leached was greater than that from the solid leached. In this case, however, the differences are not as great as they are in the case of the solid manure. Thus, we find that there was a recovery of 42.4 per cent. in the solid and liquid fresh, as against a recovery of 21.8 per cent. in the solid fresh. In the leached manures the recovery was 28.9 per cent. in the solid and liquid portion, as against 22 per cent. in the solid portion. Also, this agrees with the results of other years, and is as should be expected, for the solid and liquid leached does not contain as much soluble nitrogen as is contained in the solid and liquid fresh. It appears, also, that the recovery from the solid leached is

practically the same as the recovery from the solid fresh, and the recovery from the solid and liquid leached is not much greater than the recovery from the solid fresh.

THE RELATIVE AVAILABILITY OF THE NITROGEN IN THE FORM OF NITRATE, AMMONIA AND OF ORGANIC MATTER IN DRIED BLOOD.

The recovery from the nitrate, both where the single and the double portions were used, is smaller than usual. In series 7 only 49.9 per cent. of the amount applied was recovered, and in series 8 only 60 per cent. The recovery from the ammonium sulphate and from the dried blood was proportionately greater than that from series 7 alone, or of the average of series 7 and 8. This, naturally, makes the availability of the ammonia and dried blood nitrogen, as measured in terms of nitrate nitrogen, comparatively high. As to the recovery from the ammonia nitrogen itself, it is practically the same as that from the dried blood, the two being 57 per cent. and 56.9 per cent., respectively.

THE EFFECT OF THE USE OF THE SOLID AND OF THE SOLID AND LIQUID PORTIONS OF COW MANURE, FRESH AND LEACHED, WITH NITROGEN IN THE FORM OF NITRATE, OF AMMONIA AND OF ORGANIC MATTER.

The recovery from the combinations of the different materials is, in four cases out of the ten, greater than the calculated recovery; in four cases it is less than the calculated recovery, and in two cases the calculated and the actual recovery are practically the same. The recovery from 11 and 12, where the solid and liquid fresh was used together with nitrate, is 51.6 and 52.2 per cent., respectively, and exceeds in both cases the calculated recovery. The recovery in 9 and 10 is 35 and 32.5 per cent., respectively, and exceeds the recovery from either the solid leached or the solid and liquid leached. The recovery from 19 is less than that from 20, and in the latter it is not much different from the calculated recovery. With the exception of series 10, the recovery from the manures, both fresh and leached, is greater when used together with the double

portion of nitrate than when used with the single portion. The accompanying table shows the average percentage recovery of nitrogen when the materials furnishing it were used singly as well as when they were used in combination, together with the percentage increase of nitrogen from combinations of two materials, calculated from the increase obtained when they were used singly.

TABLE G.

	No. of Series.	Nitrogen Recovered. %	Calculated Recovery. %	Nitrogen not Recovered in the Combinations of Materials. %
Solid manure, fresh	3	21.8	......	......
Solid and liquid, fresh	4	42.4	......	......
Solid manure, leached	5	22.0	......	......
Solid and liquid, leached	6	28.9	......	......
Sodium nitrate	7	49.9	......	......
Sodium nitrate	8	60.1	......	......
Ammonium sulphate	17	57.0	......	......
Dried blood	18	56.9	......	......
7 and 3 in	9	35.0	26.38	......
8 and 3 in	10	32.5	32.45	......
7 and 4 in	11	51.6	43.61	......
8 and 4 in	12	52.2	47.29	......
7 and 5 in	13	27.3	26.47	......
8 and 5 in	14	28.8	32.57	11.57
7 and 6 in	15	29.6	32.36	8.53
8 and 6 in	16	31.6	37.67	18.39
17 and 5 in	19	28.9	32.01	9.71
18 and 5 in	20	31.2	31.69	1.6

The Availability of the Nitrogen in the Several Nitrogenous Materials.

Nitrate of soda	100
Sulphate of ammonia	94.8
Dried blood	94.7
Solid manure, fresh	36.3
Solid manure, leached	36.6
Solid and liquid, fresh	70.5
Solid and liquid, leached	48.1

These figures show that the availability of the nitrate nitrogen is greater than that of the ammonia and of the organic nitrogen in dried blod. They show that the availability of the nitrogen in the solid and liquid fresh is greater than that in the other forms of manure. They show that the availability of the nitrogen in the

solid and liquid manure leached is greater than that in either the solid fresh or the solid leached. They show that the availability of the nitrogen in the ammonia or dried blood is greater than that of the nitrogen in any of the manures. These facts have been found to be so, with but few exceptions, in the other experiments.

Changes in the Nitrogen Content of the Sandy Soils.

The study of the relative value of different nitrogenous substances has been carried on in two different soils, a shale loam and a lighter sandy loam. The derivation of these soils and their treatment have been discussed in previous reports, and it is unnecessary to consider the details here. It became expedient as the work progressed to determine in how far the soil nitrogen influenced the utilization of the manure or fertilizer nitrogen, and in how far it affected the interpretation of the results obtained. The amount of nitrogen in each cylinder was very considerable at the beginning of the experiments. In the heavier soils there was contained in each case 175 to 180 grams of nitrogen in the surface portion; in the lighter soils, derived from the first by the addition to it of an equal quantity by weight of quartz sand, there was probably contained 88 to 90 grams of nitrogen in each case at the beginning of the experiments.

The exact determination of the nitrogen in these soils presents great difficulties. Notwithstanding the greatest care in the analytical part of the work it is yet impossible to reduce the limit of error to a small fraction of one gram. This is largely due to the comparatively great amount of soil to be dealt with. Only a limited quantity of soil can be taken for the determination of nitrogen, and the least error is, therefore, multiplied enormously.

By comparing the amount of nitrogen originally present in the soil with the amount left there after a series of crops had been removed from it (taking into consideration, of course, the amounts of nitrogen applied and removed in the crops during that time), it becomes possible to determine the part played by the soil nitrogen in these experiments. In calculating the yields from the several series it was assumed that the amount of nitrogen derived in each case from the soil itself was the same and equal to that removed by the crop from series 2, where no nitrogen was applied. Thus, in series 7, for instance, the yield of nitrogen in the crop was due in

the nitrate applied and in part to the soil itself. By sub- from the total yield the amount found in the crop on series quantity of nitrogen due to the nitrate alone is found. ly, the question arose whether the amount of nitrogen re- rom the soil itself was the same in each case. This question nly be answered by the analysis of the soil. But even the lysis does not give an absolutely correct answer to this ques- part from the uncertainty due to the analytical work itself, re other factors to be considered. As to the former, it is due to the large quantity of soil dealt with, and in these ents does not exceed one gram on the total quantity of nitro- ınd, in most cases amounting to rather less than one-half This error, then, while fairly large, still allows a close ap- tion to the actual amounts of nitrogen present in the soil. act influence of the other factors mentioned above cannot be determined. Their *possible* influence will become evident e following considerations: The inert soil nitrogen contained organic portion of the soil is changed slowly. There is no hat the mineral portion of the soil exerts a great influence on ution, and since the mineral salts contained in the several re not exactly alike because of the different treatment, their action on the organic portion of the soil is variable. Where eral salts were applied together with manure, the relations l more complicated. In the first place, there occur in the ious processes of decay, during which some of the nitrogen ubtedly set free in the gaseous form, part of it as ammonia rt of it as elementary nitrogen. In the second place, there sibility, at least, that some of the nitrate, either derived from or applied as such, is denitrified when in contact with large ies of organic matter. In the third place, there exist in the number of organisms capable, under certain conditions, of tmospheric nitrogen. Moreover, some part, at least, is played nitrogen brought down to the soil in atmospheric precipita- Considering this at five pounds per acre, annually, there would ght down on the three square feet of surface in each cylin- five years, about 3 grams of soluble nitrogen. And, finally, ıble nitrates are, in part, washed into the subsoil beyond the f the plants. It will be seen, thus, that the analytical results nly the algebraic sum of these various influences. It is also that the relative influence of each of these factors is not the

same in the several series. The amount of nitrogen lost from the soil by decay will depend on the kind and number of bacteria present in the soil, and these will be determined by the conditions of moisture, temperature and reaction of the soil, as well as by its content of soluble salts. Since these conditions vary in the several series, the extent of change and the amount of nitrogen set free in this change are also variable. The addition to the soil of manure will modify its temperature and moisture conditions, hence these will not be the same in series 7 as they are in series 12, for instance. Moreover, together with the manure, there are introducd into the soil great numbers of different bacteria, which will also affect the condition of the soil nitrogen. It is well known that in the nitrification of organic or ammonia nitrogen a portion of it is set free. The extent of the loss is quite variable. In the nitrification of ammonia salts it is slight; in the nitrification of organic matter it is greater, mainly because the process in the latter case is more complex. The extent of denitrification in the soil will largely depend on the amount of organic matter added to it in the manure. It is the purpose of the cylinder experiments to determine, among other things, whether denitrification really does take place in the soil when only ordinary quantities of manure are applied. As will be shown later, both the crop analyses and the soil analyses show that there was no denitrification. As to the fixation of atmospheric nitrogen by bacteria in the cylinder soils, it is difficult to determine at present. There are one or two instances which make it appear that there was some fixation there. It was already stated that the amount of nitrogen found in the soil represents the algebraic sum of the different gains and losses, viz., the manures and fertilizers applied, the atmospheric precipitation, the possible addition from the subsoil, the fixation of atmospheric nitrogen by bacteria, removal of nitrogen by crops, denitrification, various processes of decay, leaching action of rain, etc. All these factors make it difficult to determine with certainty whether any fixation does take place. unless such fixation is very considerable.

In the spring of 1902 the soil from the three cylinders in each series was removed, placed in one pile and thoroughly mixed. A representative sample was then taken, the soil divided into three equal portions and returned to the respective cylinders. The samples were then taken to the laboratory and air-dried, showing the following results:

Weight of Moist and Air-Dry Soil.

s.	Fresh Sample. gr.	Air-Dry Sample. gr.	Loss %
	307.95	278.05	9.71
	287.20	258.05	10.15
	267.70	238.20	11.02
	266.30	238.75	10.35
	252.90	225.45	10.86
	271.50	242.05	10.85
	273.10	245.55	10.09
	264.70	238.15	10.03
	264.10	235.35	10.89
	262.60	233.65	11.03
	280.20	250.30	10.61
	264.50	234.95	11.18
	253.00	225.30	11.16
	251.70	223.35	11.31
	254.80	225.80	11.48
	272.95	242.00	11.34
	252.55	226.25	10.42
	254.75	226.90	10.93
	264.00	233.20	11.67
	262.70	234.85	10.61

ıbove table shows that the samples taken under the same con- from the several series contained varying amounts of moisture. ses indicate the water-holding power of the different soils. ically, the soils containing the greater amount of organic mat- ld also possess a greater water-holding power. The facts in e are mostly in accord with theory. Thus, on series 1, 2, 7 where no manures were applied, the humus content of the ; reduced by successive crops, and with it its water-holding for less moisture was held in the samples from these series om any of the others. The average amount of moisture lost ıese series on air-drying was 9.99 per cent., while the average om the other sixteen series was 10.98; in other words, a ce of 1 per cent. In series 9, 10, 11, 12, 13, 14, 15 and 16, manure and nitrate were applied together, the average loss eater than it was on series 3, 4, 5 and 6, where the manures sed alone, the figures being 11.12 per cent. and 10.77 per espectively. The loss from series 3 was greater than that from , while in series 5 and 6 the losses were about the same. The rom the even series, 10, 12, 14 and 16, where the double quan- nitrate was used, are, with but one exception, greater than those ıe corresponding odd series, 9, 11, 13 and 15, where the half

portion of nitrate was used. This would indicate that the water-holding power of the soil in the even series was greater than that of the soil in the odd series. The loss from series 18, where dried blood was used as the source of nitrogen, is greater than that from series 17, where ammonium sulphate was used, showing that the water-holding power of the soil in series 18 was greater than that in series 17. On the other hand, the loss from series 19 was much greater than that from series 20; in fact, greater than it was in any other series. Taken together with the fact that the nitrogen content of this soil, as well as the loss on ignition, is greater in this soil than in any other, it becomes evident that, everything being equal, the water-holding power of any soil is greater or less as its content of organic matter is greater or less. It still remains to be explained, however, why there is more organic matter and more nitrogen in series 19 than there is in any of the other series. There is a possibility, at least, that certain species of nitrogen fixing bacteria have found a congenial medium in that soil, and have enriched it at the expense of the atmospheric nitrogen. Such an assumption, however, would take us into the realm of mere speculation, and it is best to let the facts stand as they are for the present.

Hygroscopic Moisture, Total Moisture, and Volatile Matter in the Cylinder Soils.

Series.	Hygroscopic Moisture. %	Loss on Ignition. %	Loss on Ignition. Less Hygroscopic Moisture. %	Total Moisture. %
1	1.01	4.41	3.40	10.72
2	.97	4.14	3.17	11.12
3	1.00	4.47	3.47	12.02
4	.97	4.27	3.30	11.32
5	1.00	4.29	3.29	11.86
6	.88	4.17	3.29	11.73
7	.93	3.98	3.05	11.02
8	.75	3.71	2.96	10.78
9	.78	4.42	3.64	11.67
10	.84	4.08	3.24	11.87
11	.80	3.99	3.19	11.41
12	.82	4.44	3.62	12.00
13	.90	4.48	3.58	12.06
14	.87	4.48	3.61	12.18
15	.86	4.47	3.61	12.34
16	.93	4.49	3.56	12.27
17	.86	4.30	3.44	11.28
18	.81	4.46	3.65	11.74
19	.98	4.93	3.09	12.65
20	.85	4.83	3.48	11.46

The figures presented in the above table bring out some interesting relations of the volatile matter to the hygroscopic moisture. It will be noticed that the loss on ignition is greater in 1 than it is in series 2, and, similarly, the content of hygroscopic moisture in series 1 is greater than it is in series 2. The loss on ignition is greater in series 3 than it is in series 4, and, similarly, the content of hygroscopic moisture is greater in series 3 than it is in series 4. The same is true of series 7 and 8 and of series 12 and 11. The loss on ignition in 5 is equal to that in 6, but the hygroscopic moisture is greater in 5 than it is in 6. The loss on ignition in series 7 and 8 is very low, indicating that the amount of organic matter present there is smaller than it is in the other series. In series 8 the hygroscopic moisture is also lower than in any other series. The average loss on ignition from series 13, 14, 15 and 16, where the leached manures were used, is greater than that from series 9, 10, 11 and 12, where the fresh manures were used; this is largely due to the low content of volatile matter in series 10 and 11. Barring series 7 and 8, the lowest content of volatile matter is found in series 2, which is in agreement with other facts. There is a greater loss on ignition from series 18 than there is from series 17; on the other hand, the loss on ignition from 19 is greater than it is from 20, and, moreover, the loss from 19 is greater than that from any other series. This fact will be considered again later on. Comparing the total moisture content in the several series, we find that it is greater in series 2 than it is in series 1, and greater in 3 and 5 than it is in 4 and 6, respectively. The total content of moisture is greater in 7 than it is in 8; but, when these are used in combination, we find that in most cases the water-holding power of the soils where the double quantity of nitrates was used was greater than that in the corresponding series, where the single quantity of nitrate was used. Thus, it is greater in 10, 12 and 14 than it is in 9, 11 and 13, respectively. Similarly, the total moisture was greater in 18 than it was in 17, although the reverse is true of 19 and 20. It has been pointed out already that for some reason the content of organic matter and of nitrogen are abnormally high in series 19. Since the water-holding power of a soil is determined in a measure by its content of organic matter, it becomes clear why the total moisture, as well as the hygroscopic moisture, are higher in series 19 than they are in any other series. It will also be observed that the total moisture is greater in series 13, 14, 15 and 16, where the leached manures were used, than it is in series 9, 10, 11 and 12, where the fresh manures were used.

The Income and Outgo of Nitrogen in the Different Series.

The sandy loam soils considered here were made up of the shale soil used in other series and of quartz sand, one part by weight being taken of each. The former was obtained from a vacant lot near the Experiment Station building. So far as is known, this soil was never under cultivation, and it is quite certain that no crops had been grown upon it for twenty years or more. On analysis, this wild soil proved to be very rich in nitrogen. The quartz sand, presumably, contained no nitrogen, although it is quite likely that it contained small amounts of it. It was not thought at the time the cylinder experiments were started that the sand would be required for analytical examination, and no sample of it was, therefore, preserved. Hence the possible content of nitrogen in the sand itself is disregarded here, and the calculations made on the basis of the shale soil alone, one-half of the total weight of the soil in each cylinder being regarded as sand. When the cylinder experiments were begun in 1898, and the soils weighed off, equal quantities were presumably taken for the several cylinders. On sampling the soils for analysis in the spring of 1902, the soils from the three cylinders in each series were mixed, weighed in mass and exactly one-third returned to each cylinder. These second weighings, when calculated to the water-free basis, showed, however, that the absolute amounts were not the same in each case, and for this reason it became necessary to allow for the difference in calculating the total amount of nitrogen contained in each series and each cylinder. The following are the amounts of water-free soil found in each series, the figures in each case representing one-third of the total weight of soil in the series:

Amounts of Water-Free Soil per Cylinder.

Series.	Grams.	Series.	Grams.
1	87.985	11	88.384
2	87.154	12	87.848
3	89.507	13	86.192
4	90.053	14	87.259
5	87.924	15	85.916
6	88.052	16	87.168
7	89.304	17	88.157
8	90.667	18	88.095
9	88.562	19	87.187
10	87.215	20	87.564

following table gives the average amount of the nitrogen in ries, the total amount applied from 1898 until the spring of e amount removed in the crops during that time, the amount as found by analysis and the amount not accounted for, repre- the loss from all causes. It will be noticed that in every vithout exception, there was a loss of nitrogen, the minimum 3.10 grams in series 18 and the maximum 26.89 grams, or double the least loss in series 4. This does not take into ac- he amounts of soluble nitrogen probably added to the several s in atmospheric precipitation, and which may have amounted or three grams per cylinders for the four years. The data d here remind us again quite forcibly that there is an enor- ss of nitrogen from out arable soils, a loss that is bound to sooner or later unless the proper means are taken to retard ses. Our investigations have not as yet proceeded far enough us what proportion of the loss is due to the draining away lissolved nitrogen from the soil and what proportion of it is he liberation of elementary nitrogen in the various processes of But the indisputable fact is that very considerable losses do In series 4, for instance, this loss is more than 29 per cent. mount originally present, and the average loss is more than cent. or one-fifth of the amount originally present. These s the table shows, are fairly uniform, although apparently able differences occur. In series 1 the loss was somewhat than in series 2, due probably to the fact that the growth on was always slight and not capable of exploiting much of the ogen as it became available. This reasoning need not neces- pply to series 7 and 8 or to series 17 and 18, for on these t development, though differing in extent, was always normal. from series 4, where solid and liquid manure fresh was ap- greater than that from series 3, where solid fresh was used. ems reasonable enough, since a considerable portion of the on series 4 was applied in the soluble and easily decomposed More strange is the fact that the loss from series 3 is practi- e same as that from series 1. This means either that there little loss from the manure itself or that the manure dimin- e loss of the soil nitrogen. In the leached manures, the loss ies 6, where the solid and liquid portions were used together, er than that from series 5, where the solid leached was used ut the difference, as would be expected, is not as great here between the fresh manures.

Amount of Nitrogen Present in the Soil.

The losses from the other series will be considered in the discussion of the effectiveness of the different combinations. In this place attention is called to the content of nitrogen in the different series. It was stated elsewhere that where nitrate alone was used the plants were enabled to obtain a greater amount of nitrogen from the soil itself than the plants on series 2, where no nitrogen was applied, and where the plants were, therefore, less vigorous. Similarly, since the crops in series 2 removed more nitrogen than those of series 1, the soil of the former should contain less nitrogen than the soil of the latter. As to series 1 and 2, we find this to be the case, but in series 7 and 8 there is apparently more nitrogen than in series 2. The difference is only seeming, however, for series 7 and 8 contain more soil than series 2. There is no doubt that a greater part of the soil nitrogen, which drained away as it became soluble, was captured by the plants of series 7 and 8 than there was captured on series 2. Some of this nitrogen was again made insoluble and left in the soil as roots and stubble, a proportionately greater amount being left on 7 and 8 than there was on 2, and hence the analytical data do not show differences as they really are. The soil in series 3 contains more nitrogen than that in series 4, and the soil in series 5 a slightly greater quantity than the soil in series 6. It also appears that in the even series, 10, 12, 14 and 16 (with but one exception), the amounts of nitrogen present in the soil are greater than in the odd series, 9, 11, 13 and 15, where the single quantity of nitrate was used with the respective manures. There is, on the average, more nitrogen in the soils of series 13, 14, 15 and 16, where the leached manures were used in combination with nitrate, than there is in the series 9, 11, 13 and 15, where the fresh manures were used in combination with nitrate. With but one exception, there is more nitrogen present in the soils where the solid manures were used in combination with nitrate than there is in the soils where the solid and liquid manures were used in combination with nitrate. More nitrogen is present in series 18 than there is in series 17, although there was more of it applied to, and less removed from, the latter. In series 19 there is more nitrogen present than in any other series, yet the reason for this is not yet clear. It is possible that the sulphuric acid derived from the ammonium sulphate (the latter being nitrified) diminished the loss of the ammonia formed from the humus of the soil and from

the manure; or it may be that there was fixation of atmospheric nitrogen in series 19, where the nitrogen fixing bacteria have found more favorable conditions for their development.

Nitrogen in Sandy Loam.

Cylinder Soils.

Series.	Nitrogen Originally Present. gr.	Applied. gr.	Removed. gr.	Present. gr.	Loss. gr.
1	89.73	......	8.199	62.27	19.26
2	88.85	......	9.807	60 27	18.77
3	91.24	20.19	16.746	75.32	19.36
4	91.80	22.68	16.545	71.04	26.89
5	89 65	18.07	13 281	72.77	21.67
6	89.77	20.56	15.058	72.43	22.84
7	91.04	3.92	11.687	62.38	20.89
8	92.43	7.80	14.602	61.80	23.83
9	90.29	24.11	17.047	72.54	24.81
10	88.94	27.99	18.065	79 41	19.46
11	90.09	26.60	21.629	73.62	21.34
12	88.76	30.48	21.322	76.43	21.49
13	87.88	21.99	15.649	77.20	17.02
14	88.97	25.87	18.293	78.30	18.25
15	87.58	24.48	18.745	76.81	16.51
16	88.86	28.36	19.432	75.13	22.66
17	89.87	8.03	12.849	67.91	17.14
18	89.82	7.55	15.891	68.38	13.10
16	88.89	26.10	16.077	82.80	16.11
20	89.27	25.62	14.446	76.79	23.65

The following table shows the effectiveness of the different combinations from the soil standpoint. The calculated loss was obtained in each case by taking the sum of the losses that occurred where the materials were used singly. Thus the calculated loss in series 9 represents the loss in series 3, less the loss on series 2 (check plot), plus the loss in series 7, less the loss in series 2. The actual loss was obtained in each case by subtracting from the sum of the initial and the applied nitrogen the amount removed in the crops, as well as that found to be still present in the soil. The figures show that in most cases there was a slighter loss than the calculated, and they prove that there was apparently no denitrification in any of the series where the nitrate was used together with manure. In series 9 and 20 there was a loss over the amount calculated. In these the loss

could hardly be due to denitrification, surely not in 20, for no nitrate was used here. As to series 9, if the loss was due to denitrification there should have been a still greater loss in series 10, where the same manure was used with the double quantity of nitrate. It seems, on the contrary, that in almost every case there was a greater gain over the calculated in the series where the double quantity of nitrate was used, as against the corresponding series, where only the single quantity of nitrate was used.

Losses of Nitrogen from the Soils.

Series.	Calculated Loss. gr.	Actual Loss. gr.	Gain or Loss over Calculated. gr.
9	2.71	6.04	— 3.33
10	5.65	.69	+ 4.96
11	10.14	2.57	+ 7.56
12	13.08	2.72	+10.36
13	5.02	+1.75	+ 6.77
14	7.96	+0.52	+ 8.48
15	6.19	+2.26	+ 8.45
16	9.13	3.89	+ 5.24
19	1.27	+2.66	+ 3.93
20	+2.77	4.88	— 7.65

REPORT OF THE ASSISTANT IN SOIL CHEMISTRY AND BACTERIOLOGY.

OIL CHEMISTRY AND BACTERIOLOGY.

ntributions to the Morphology and the Physiology of Denitrification.

phytic organisms, whether molds or bacteria, utilizing for evelopment dead organic tissue, cause in the latter more or p-seated changes. These changes frequently lead to very cone losses of nitrogen, whose extent is determined by the char- the decaying substance, by the organisms present and by the ns under which the decomposition takes place. Realizing t importance of such processes to agriculture, many investigae occupied themselves with the subject, endeavoring to make e nature of decay, both in the presence and in the absence of and to suggest measures whereby the losses of nitrogen may ced to a minimum. The greatest difficulty encountered in vestigations is the uncertainty of one factor—the organisms substance undergoing decay. For it happens that the least in the conditions of the experiment disturbs the established ium, new species come to the foreground, new physiological s become prominent, new products are formed and new re- take place. In this case it is assumed, of course, that the osition is taking place under natural conditions, where the nation from the surroundings is not excluded. But, in order rstand the processes of decay in their simplest form, it beecessary to study the physiological activities of single species culture, for only in this way can the problem be reduced to which are sufficiently exact. The data thus secured can be with great advantage in the examination of the complex s where mixtures of bacteria are dealt with, and where ry reactions play an important part.

large quantities of organic matter decay in the presence of , the latter are deoxidized, and the reduction may be carried enough to lead to the evolution of free nitrogen. The true

significance of the partial or complete deoxidation of nitrate in agriculture, as gauged by the present-day knowledge, will be discussed elsewhere. But in this place it should be noted that enormous quantities of nitrogen are lost in the various processes of decay, even when nitrates are absent. Losses of nitrogen occur from the manure in the stable and from the manure heap, and losses also occur from that manure after it is placed in the soil. Of the nitrogen contained in the fresh manure but a small proportion is required in the crops, and it is doubtful whether, on the average, more than 25 per cent. are recovered.[1] With a better understanding of the processes of decay, much could be done to diminish such losses. Even if the utilization of the manure-nitrogen should be increased 10 per cent., the gains to agriculture would be great. It is quite evident that the losses of nitrogen are greater where there is a proportionately greater amount of it in soluble compounds. Thus in the decomposition of liquid manure, its soluble nitrogen compounds, whether urea or hippuric acid, are readily broken down and ammonia liberated. The reactions may be represented as follows:

$$\underset{\text{Urea.}}{CO\left\{\begin{matrix}NH_2\\NH_2\end{matrix}\right.} + H_2O = CO_2 + 2NH_3.$$

$$\text{or, } \underset{\text{Hippuric acid.}}{CO_2H\,CH_2-NH\,CO\,C_6H_5} + H_2O = \underset{\text{Glycocol.}}{CH_2-NH_2\,COOH} + \underset{\text{Benzoic acid.}}{C_6H_5\,COOH}$$

$$\text{and } CH_2\,NH_2\,COOH + H_2O = CH_2\,OH\,COOH + NH_3.$$

These reactions represent a type of ammoniacal fermentation which is quite common, leading to the volatilization of ammonia by the changes in the amido-compounds. At the same time the nitrogen from decaying organic substances may be set free in its elementary state, although it is still a disputed point as to what extent the latter takes place. There are a number of experiments carefully planned and carefully carried out which seem to prove that no nitrogen is set free as such from decaying nitrogenous substances, and there are experiments seemingly accurate which indicate that such losses do occur. It should be borne in mind, however, that the character of decompostion is determined by the supply of oxygen. With a plenti-

[1] See Wagner & Dorsch, Die Stickstoffdüngung der landwirtschaftlichen Kulturpflanzen, p. 247. E. B. Voorhees, New Jersey Sta. Rep. 1901, p. 179. Adolf Mayer, Agriculturchemie, II. vol., part 2, 5th edition, p. 51. Wollny, Die Zersetzung der organischen Stoffe, p. 407.

ful supply of the later, oxidizing processes prevail, and the ammonia is gradually oxidized to nitrates and nitrites. Where the supply of oxygen is cut off, or is limited, the reducing processes prevail—there is only a partial decomposition of the substance, with scarcely any loss of nitrogen. The first type of decomposition is called *decay*, the second, *putrefaction*. However, it is not always easy to draw the line of demarcation, especially where large quantities of organic material are undergoing decay. As to putrefaction, the preponderance of opinion is that no appreciable loss of gaseous nitrogen takes place here. Immendorff[1] supports this view, and quotes Kellner,[2] Tacke,[3] Ehrenberg[4] and Schlösing,[5] to the same effect. Similar conclusions are reached by Müntz and Girard (Ann. Agron. 19, 1893, pp. 5–49), Schneidewind,[6] Dietzell[7] and Pfeiffer.[8] Dietzell finds from his experiments that "the loss of nitrogen and of organic substance is avoided when no aeration can take place. On the other hand, there is some evidence to show that free nitrogen is evolved in processes of putrefaction.

Wollny[9] cites König and Kiesow,[10] Dietzell,[11] Morgen and König,[12] as supporting this view, but, on summing up the evidence, he concludes that "no free nitrogen is split off in the putretative decomposition of organic substances."

Conditions are quite different in decay proper. The different investigators are not unanimous on the subject, and it will be seen below how the apparent discrepancies may be accounted for. Careful measurement and analysis of the gases evolved lead Ehrenberg[13] to decide that no elementary nitrogen is liberated in decay, when there is a plentiful supply of oxygen. Opposed to this are the re-

[1] **Landw. Jahrb. 21 (1892), p. 281.**
[2] **Ztschr. physiol. Chemie (1887), XII., p. 95.**
[3] **Landw. Jahrb. (1887), XVI., p. 917.**
[4] **Ztschr. physiol. Chemie (1887), XII., pp. 145 and 438.**
[5] **Compt. Rend. (1889), CIX., p. 835.**
[6] **Journ. f. Landw. 45, p. 173.**
[7] **Landw. Vers. Stat. 48 (1896), p. 177.**
[8] **Landw. Vers. Stat. 48 (1896), p. 243.**
[9] **Die Zersetzung der organischen Stoffe, pp. 12–13.**
[10] **Landw. Jahrb., vol. II. (1873), p. 107.**
[11] **Ztschr. des Landw. Vereins in Bayern, March, 1882.**
[12] **Landw. Vers. Stat., XXX. (1884), pp. 199–216.**
[13] **Zeitschr., physiol. Chemie., XI. (1887), p. 439.**

sults obtained by Tacke,[1] which lead him to believe that "in the oxidation of ammonia, as well as in the reduction of nitric acid to ammonia, conditions may arise where two nascent N atoms can combine into molecular N and escape from the decaying mass." Immendorff[2] sums up the matter as follows: "Aus meinen Versuchen geht also in erster Linie hervor das durch den Verwesungs-Process, bei reichlichen Gegenwart von Sauerstoff, Stickstoffverluste durch Freiwerden dieses Elementes eintreten können." Schneidewind[3] admits that losses of free nitrogen may at times occur, and further evidence on the subject is furnished by Pfeiffer,[4] Godlewski,[5] Stutzer and Hartleb,[6] and others. After comparing the evidence, Wollny[7] says: "Wird man die, Frage, ob bie der Verwesung Stickstoffhaltiger organischer Stoffe direct oder nach vorgängiger Salpeterbildung freier Stickstoff entbunden wird, also eine offene bezeichnen müssen." He ascribes the differences to the *conditions* of the experiment and believes that because of incomplete aeration there was partial putrefactive decomposition alongside of the decay proper. "And, for the rest," he says, "the number of experiments thus far carried out are quite insufficient to offer a final answer to the question. That will be possible only when the life conditions of the organisms concerned with these processes will be studied more thoroughly, and the chemical composition of the various products of decay will be determined." The author does not emphasize, however, the influence of the organisms themselves and the peculiarities of the different species. The fact that different results were obtained by investigators who worked under similar, but not identical, conditions is in itself sufficient to indicate the status of the subject. An experiment of Gibson's seems to prove the point in question.[8] Gibson inoculated lean beef and blood serum with an infusion from putrefying meat, on the one hand, and with soil solution on the other, no more than a few drops of inoculation being used in each case. He reaches the following conclusions: (1) Liberation of nitrogen may take place during the

[1] Landw. Jahrb. 16 (1887), p. 917.
[2] Landw. Jahrb. 21 (1892), p. 281.
[3] Jour. f. Landw. 45 (1897), p. 176.
[4] Landw. Vers. Stat. 48 (1896), p. 202.
[5] Abstr. in Centr. f. Bact., part II., vol. II. (1896), p. 462.
[6] Centr. f. Bact., part II., vol. 44 (1898), p. 31.
[7] L. c., p. 6.
[8] Amer. Chem. Jour. 15 (1893), pp. 12–18.

process of putrefaction; (2) In the experiments reported, the liberation of nitrogen has been dependent on the inoculation, and certain organisms (found in the putrid flesh) seem incapable of carrying on this process to any marked degree, while others (found in the soil infusion) have produced the liberation of nitrogen independent of the process of nitrification. There is no doubt that the meat infusion and the soil solution contained different organisms, with different physiological activities, and it is but natural that the expression of these activities in the results obtained should be different. And the contradictory results obtained by several careful investigators make it appear that not enough attention had been paid to the agents of decay. That these are a very important factor, at all times to be reckoned with, will appear from the following experiments, carried on in this laboratory:

Losses of Nitrogen in Solutions Free from Nitrates.

These experiments were carried out with pure cultures of the several organisms, and, in one case, with a mixture of soil bacteria. In each case 25 cc. of nutrient bouillon were pipetted off into 200 cc. Erlenmeyer flasks, plugged, sterilized in the autoclave, and, on cooling, inoculated as follows:

1. Sterile.	9. B. pyocyaneus.
2. "	10. "
3. B. coli commune.	11. B. megatherium.
4. " "	12. "
5. B. subtilis.	13. B. New Jersey.
6. "	14. "
7. B. fluorescens liquefaciens.	15. Mixture of soil bacteria.
8. " "	16. " " "

All of the inoculations, with the exception of B. coli commune, made rapid growth. In the latter there was very little preceptible growth, owing, undoubtedly, to the old material used for inoculation. At the endof fifteen days 1 and 2 were clear, 3 and 4 slightly cloudy, 11 and 12 clear, with some white deposit, and the others all turbid, with a greater or less quantity of white, or dirty white deposit. The cultures were then sterilized, and basic lead acetate added to precipitate the bodies of the bacteria. This precipitated, also, the peptone contained in the bouillon. The solutions were filtered, washed and the nitrogen determined according to the Kjeldahl method, in the soluble and the insoluble portion separately, with the following results:

No. of Sample.	Insoluble Nit.	Soluble Nit.	Total Nit.	Average.
1. Sterile	9.00 mg.	50.76 mg.	59.76 mg.	59.53 mg.
2. "	8.70 "	50.61 "	59.31 "	
3. B. coli	11.31 "	48.06 "	59.37 "	59.62 "
4. "	11.46 "	48.41 "	59.87 "	
5. B. subtilis	4.71 "	38.66 "	43.37 "	44.32 "
6. "	6.51 "	38.76 "	45.27 "	
7. B. fluorescens liqu	15 36 "	34.41 "	49.77 "	50.64 %.
8. " "	15.45 "	36.06 "	51.51 "	
9. B. pyocyaneus	14.61 "	39.72 "	54.33 "	52.57 "
10. "	15.96 "	34 86 "	50 82 "	
11. B. megatherium	9.06 "	47.90 "	56 96 "	57.23 "
12. "	9.45 "	48.06 "	57.51 "	
13. B. New Jersey	14.85 "	43.71 "	58.56 "	58.77 "
14. "	14.91 "	44.07 "	58.98 "	
15. Mixture	13.26 "	26.46 "	39.72 "	38.59 "
16. "	13.56 "	23.91 "	37.47 "	

With the exception of B. coli, which made practically no growth at all, the several organisms caused varying and yet considerable losses of nitrogen in the fifteen days of the experiment. The proportionate losses were as follows:

B. subtilis	25.6 %.	B. megatherium	3.9 %.
B fluor. liqu	14.5 "	B. New Jersey	1.3 "
B. pyocyaneus	11.7 "	Mixture	35.2 "

These figures show that, even under the same conditions, the different organisms have produced varying results. No attempt was made to determine whether the losses occurred from the volatilization of ammonia, or of volatile organic nitrogen compounds, from the evolution of oxides of nitrogen, or of free nitrogen. Nevertheless it can be seen from the amounts of insoluble organic nitrogen produced that the losses were not necessarily greatest where the development was greatest. Thus we find that B. fluorescens liquefaciens has assimilated a greater amount of the soluble nitrogen, originally present in the solution, than any of the other organisms, and yet the losses of nitrogen were not as great here as they were in samples 15 and 16, inoculated with a mixture of soil bacteria. Strangely enough, less insoluble organic nitrogen was found in 5 and 6, inoculated with B. subtilis, than was found in the blanks. It is possible that the peptone was attacked by these bacteria in preference to the other constituents of the bouillon, and destroyed, while comparatively little of it was used to build up their body substance. Comparing B.

-ium and B. New Jersey, we find that, although there was -wth and but a slight deposit in the flasks inoculated with -er, and abundant growth and a copious deposit in the flasks -d with the latter, none the less the loss of nitrogen caused -ew Jersey was just one-third of that produced by B. Mega- (1.3 per cent., as against 3.9 per cent.), and in neither case losses as considerable as in the other samples. The greatest -curred in the inoculation with B. subtilis and with the mix- -oil bacteria, amounting to 25.6 per cent. and 35.2 per cent., -ely. These are enormous losses for so short a period. It -oticed that in 15 and 16, inoculated in the soil bacteria, the of soluble nitrogen found at the end of the experiment were -lf of that originally present in the sample. On the whole, -riment shows that single species differ as to the effect they on the medium in which they grow; that the loss of nitro- -ot proportionate to the amounts rendered insoluble; that the the nitrogen solution is decreased, not only by the direct also by the change of the soluble forms into insoluble and -ually available forms. Moreover, it appears that when mix- bacteria grow in nitrogen solutions they are apt to cause -osses of nitrogen than are caused by single species. Of -he work is but preliminary, and further studies will be nec- allow a better understanding of the subject.

-sses of Nitrogen from Solutions Containing Nitrates.

-ification is essentially a reducing process. In its narrower -e term is used to designate the complete deoxidation of ni- -th the evolution of free nitrogen; in a broader way, the term -nes employed to designate the partial reduction of nitrates -es. The power of partial reduction is common to many bac- -d even molds and yeasts. Maasen[1] found that out of the -ies of bacteria which he examined, 85 had the power of re- -nitrates to nitrites. Wolf[2] attributes this power, also, to -d yeasts. Sewerin,[3] in his study of the bacteria occurring in -nure, found that out of 29 species examined, 2 could destroy

-f. Bact., part II., vol. VIII. (1902), p. 152.

-ische Rundschon, Jahrg. IX., No. 11, abstr. in Centr. f. Bact., V. (1899),

-f. Bact. part II., vol. III. (1897), p. 504.

nitrates completely and 9 could reduce nitrates to nitrites. There have been described, in a manner sufficiently accurate, 17 or 18 organisms capable of destroying nitrates completely. These were found in different places, viz., in manure (horse and cow manure), in the soil, air, flowing water, and even the sea.[1] Denitrifying bacteria are always present in horse manure and seldom absent from cow manure; on the other hand, they are not prominent in the excreta of carnivorous animals, probably because their activities are obscured by the bacteria in the digestive tract of the latter.[2] The denitrifying bacteria found in the soil are also frequently obscured by the others, so that often no fermentation takes place in nitrate bouillon inoculated with soil.

As Lemmermann justly observes,[3] the mere inoculation of nitrate bouillon with soil is not sufficient to show whether denitrifying organisms are present there or not. On the one hand, the nitrate reaction may disappear, even though no denitrifying bacteria be present, and on the other hand, the nitrate may remain intact notwithstanding the presence of denitrifying bacteria. In the first instance, the nitrates may be converted into organic combinations; in the second instance, the denitrifying bacteria may be suppressed by the others present in the solution. Künnemann[4] was able to observe denitrification in inoculations from five soils out of seven, and in this laboratory denitrification was observed in inoculations from two soils out of three. While there is no doubt, therefore, that denitrifying bacteria are present in moist soils, yet it should be noted that the addition of soil to a water solution of nitrates does not cause denitrification; for a considerable quantity of suitable organic matter must also be present, in order to furnish the denitrifying bacteria the energy required. Hofflich has attempted to determine whether the denitrifying organisms occurring in the soil are derived from the manures applied, or whether there are distinct species of denitrifying bacteria in the soil. He found[5] one or more species of denitrifying bacteria in each of the thirteen soils which he examined, and comes to the following conclusions:

[1] See Höfflich, Centr. f. Bact., part II., vol. VIII., p. 245; Lemmermann, Kritische Studien über Denitrificationsvorgänge, Jena (1900), pp. 21–22; Baur, Abstr. in Centr. f. Bact., part II., vol. VIII. (1902), p. 537.

[2] Jensen, Centr. f. Bact., part II., vol. IV., p. 448.

[3] L. c., p. 25.

[4] Landw. Vers. Stat. 50, p. 97.

[5] Centr. f. Bact., part II., vol. VIII., p. 404.

enitrifying bacteria are always present in the soil.
here is no decided difference between manured and unmanured regards their content of denitrifying bacteria.
he denitrifying bacteria present in the soil may survive there hen manure is not applied every year.
oils have no denitrifying bacteria peculiar to themselves; they e same species that are found in manure.
he denitrifying bacteria of the manure, the straw and the any region bear an intimate relation to one another.
he bacteria studied in this laboratory, several were isolated ow and horse manures; others were secured from the bacterio- laboratories of the University of Pennsylvania and of Cor- iiversity, through the kindness of Dr. Abbot and of Dr. V. A.

first attempts at the isolation of denitrifying bacteria were ith .32 per cent. solution of sodium nitrate in water, to which quantities of horse manure were added. One hundred cubic eters of the nitrate solution were placed in small Erlenmeyer and to the different flasks, 5, 3, 2 and 1 gr., respectively, of nanure were added. Within twenty-four hours fine bubbles o rise to the surface in the flasks to which 5 gr. of horse ma- ad been added; there was scarcely any fermentation where ad been added, and none at all in the flasks where 1 gr. had lded. When tested, after seven days, with diphenylamine and ilic acid and naphthylamine for nitrates and nitrites, re- ely, it was found that both had disappeared in the flasks to 5 gr. of manure had been added. On the other hand, there trong reaction for nitrites in the flasks to which only 1 or 2 iorse manure had been added. This shows that with the same ms at the start, the reduction was not the same, and that the quantity of organic matter allowed a more complete reduc- Furthermore, in all flasks where the reduction was greatest, ction of the liquid was alkaline to litmus paper, while in the here the reaction for nitrites was most intense the liquid und to be neutral to litmus paper. Inoculation was made iese flasks into sterile bouillon containing .3 per cent. of KNO_3. ntation with the accompanying fine bubbles became apparent twenty-four hours. From the fermenting bouillon, reinocu- vas made into fresh tubes of nitrate bouillon, and that repeated ve or six reinoculations had been made. In this way most

of the undesirable non-denitrifying bacte
the isolation on agar or gelatine plates ma
tube agar plates were prepared, and the d
appeared, were inoculated into nitrate bou
this way it was found that at least two o
the horse manure, which were capable of de
evolution of free nitrogen. These were rep
until the cultural characteristics became
then, that neither of them had been hithert
rifying organisms, nor elsewhere, as far
The two resemble one another very closely i
istics, yet show some marked differences.
classed as a variety of the other. It was de
the State where they were found, and one
Jersey, the other Bacillus New Jersey varie
tion is attempted it should be added here t
denitrifying organisms was more readily acc
for many of the accompanying organisms li
ing more rapidly than the denitrifying ba
latter. It was also found that both B. New
sey var. grow almost as well at room temp
C. In artificial bouillon made up of nitr
salts and sodium citrate and glucose as the
mentation, while it took place with the ulti
trate, was nevertheless considerably delaye
be as favorable a medium for the develop
bacteria as was the .3 per cent. nitrate bou

Cultural Characteristics of B.

GELATIN COLONIES.

The colonies grew very slowly on gelatin a
but few superficial colonies appear. In fou
raised, whitish (on blue background), tra
very small. On white background the c
translucent, with denser centre, and indica
ture. Under low power the superficial colon
ish, entire, granular in structure and de
In eight days the superficial colonies app

raised, with smooth centre, dirty-white, with the edges of the lobes somewhat denser. When examined with low magnification the lobes appear to be connected by branchings from the denser round centre, the lobes themselves showing layers of cells parallel to the edge and giving it the appearance of concentric structure. The darker centre seems as if surrounded by a transparent sheath; some of the superficial colonies are 3 mm. in diameter and at times even more. The deep colonies are yellowish, spherical and look like chestnut burrs.

AGAR COLONIES.

In five days the superficial colonies are flat, thin, skin-like, wrinkled like the skin of a pea, irregular, streaming, sometimes growing out in long, narrow strips. Ultimately the colonies spread out considerably, attaining a size (when there are few on the plate) of 6 to 7 cm. With low magnification there appear the yellow centres, somewhat sunken at times, radiating in all directions the streaming bands, which are intersected by lines so as to appear like the structure of some vegetable cell wall. At times the colonies remain round, but show the characteristic wrinkled appearance. In some cases the external zone radiates from the yellowish centre in the form of streamers, resembling turkey feathers. The markings are often parallel to the circumference and more prominent than the longitudinal markings. Below the surface the colonies are spherical, yellowish, often radiating ribs, such as serve as a network for the streaming superficial colonies.

POTATO.

No visible growth, even after two weeks or more.

BOUILLON.

In twenty-four hours, cloudiness. In three days, a slight deposit, moderately turbid, with a thread-like filament adhering to the walls of the tube at the surface.

NITRATE BOUILLON.

In twenty-four hours, moderately turbid. In two days, turbid, with layer of bubbles at the surface, showing that fermentation is far advanced or complete. The deposit rising, in one piece, from bottom on twirling the tube. It is yellowish-white and resembles a piece of precipitated peptone. There is a tendency for the white, suspended particles to settle gradually, with the upper portion of the liquid thus becoming clear.

MILK.

No apparent change for some days. In seven days, a slight layer on surface, with some yellowish deposit. In two weeks, coagulation to a semi-solid, pale, translucent mass. In time the entire mass becomes coagulated.

NITRATE MILK.

In two days, fine bubbles rising to the surface, otherwise no apparent change. In seven days it is somewhat thicker than the milk to which no nitrate had been added. In two weeks, solidification more pronounced, with a clear, yellowish serum on surface, in narrow layer, above semi-solid mass.

GELATIN STAB.

In three days the growth is narrow, filliform along the entire canal, but weakening as it proceeds downward, made up of bright, glistening granules. Crater-like formation around puncture at surface, border raised, glistening, flesh-colored, uneven. In eight days' growth on surface, more extensive than above, lobed, thicker, wrinkled, glistening and translucent at the borders. In depth, essentially as above.

Plate I

Gelatin colonies of B. New Jersey.

1-4. Superficial colonies, natural size. 5. Superficial colony, magnified five times.
6 and 7. Internal colonies, slightly enlarged.

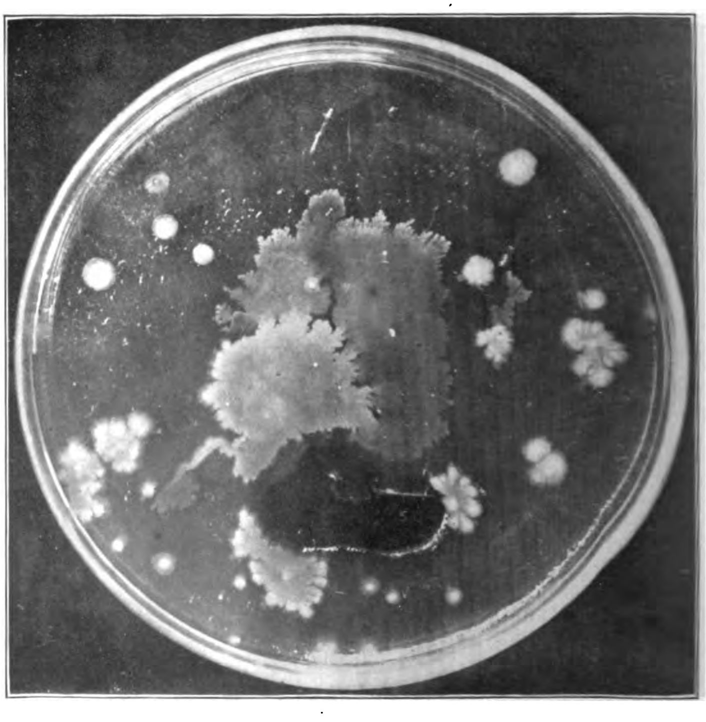

Plate II.

Agar colonies of B. New Jersey.

Photograph of agar plate, showing superficial colonies.

GELATIN SLANT.

In two days' growth, skin-like, glistening; under slight magnification it has the appearance of frosted glass, with an irregular, raised border. In eight days' growth, glistening, borders raised, lobed and fringed, rugose, translucent and pitted (due to many round, whitish particles). It is whitish in transmitted light. At the extreme lower end the border is followed by a narrower, glistening zone, which is smooth and raised.

AGAR STAB.

In twenty-fours' growth, cone-shaped, reaching within a few millimeters of the bottom of the test-tube. At surface, flat, limited, cloudy deposit around punctures. In seven days, the surface growth spreading to the walls of the tube, then dry, pitted, whitish, with raised border. In depth, narrow, cone-shaped, and not reaching the bottom of the tube.

AGAR SLANT.

In twenty-four hours, a wide, bluish-white band of growth, entire surface clouded, condensation water turbid, with more abundant growth near surface. In two days' growth, extensive and flat in the upper portion of the slant, where it can be seen, with a low magnification, to consist of circular units. These are composed of a denser, white, central mass, a narrow, thinner zone, a denser band again, and of wings more irregular in outline, thin and cloudy. In the lower portion of the slant the growth is folded and ridged, as already observed in the colonies on the agar plates; it covers the entire lower portion of the slant, is thin, flat, dry, glistening, with irregular borders. Copious flaky particles in the condensation water.

FERMENTATION TUBES.

Copious growth in lactose, saccharose and glucose bouillon, with heavy turbidity, but in no case was gas production observed.

MORPHOLOGY.

From three-days'-old agar culture the organisms appear as short rods, with rounded ends, occurring singly or in pairs. They stain readily with carbol fuchsin, showing the polar stain, but with greater difficulty with the watery stains. They are decolorized by Gram's method.

MOTILITY.

Both progressive and rotary motility were observed.

SPORE.

No spore formation was observed.

SIZE.

Repeated measurements show them to be, in young agar cultures, 1.8–2.2–2.4 microns long and .7–.8 microns wide.

BEHAVIOR IN ARTIFICIAL SOLUTIONS.

An artificial solution was prepared similar to that used by Giltay and Aberson,[1] except that different sources of nitrogent were used. The solution contained, in one liter, 2 gr. magnesium sulphate, 2 gr. potassium phosphate, 2 gr. calcium chloride, 5 gr. citric acid, 2 gr. glucose and 2 drops of ferric chloride. Besides these, there was also added in the different samples some nitrogen salt, or peptone, at the rate of 2 gr. per liter. The nitrogenous substances used were potassium nitrate, ammonium chloride, potassium nitrite and peptone.

[1] Archiv. Neerland, vol. XXX., pp. 341–361, quoted by Burri and Stutzer, Centr. f. Bact., part II., vol. I., p. 393.

B NEW JERSEY IN

Artificial solution	without	nitrogen	(in three days)—	Slight turbidity.	
"	" and	KNO_3	"	Moderate	"
"	" "	KNO_2	"	Slight	"
"	" "	NH_4Cl	"	Moderate	"
"	" "	Peptone	"	Moderate	"

IN NINE DAYS.

With no nitrogen—Faint turbidity.
" KNO_3—Strongly turbid, large bubbles, deposit.
" KNO_2—Turbid, slight deposit.
" NH_4Cl—Turbid, brownish deposit, layer on surface.
" Peptone—Moderate turbidity, slight deposit, slight pellicle.

It appears from the above that the growth with potassium nitrite as the only source of nitrogen was by no means as extensive as it was where potassium nitrate was used. The growth where ammonium chloride was used was rather peculiar. Crystals were deposited on the walls of the tube and the deposit was more considerable than it was in the other cases, and brownish in color. There was a slight development where no nitrogen at all was added, and it is possible that it was due to the slight amount of nitrogen probably present in the water (tap water was used here). The peptone did not, apparently, offer as good a source of nitrogen as did the potassium nitrate or the ammonium chloride, and in no case was there as much development as in ordinary bouillon. Tubes of bouillon containing 2 gr. of potassium nitrite per liter showed fermentation, with the accompanying fine bubbles, in two days.

B. NEW JERSEY VAR.

This organism differs from B. New Jersey, particularly in the form of its colonies on agar. The deep colonies are yellowish and of mulberry form, and considerably smaller than those of B. New Jersey. The superficial colonies are round or roundish, somewhat loosely woven, yellowish, tend to be punctiform at centre, soft, raised, tend to be wrinkled, but not as B. New Jersey, and do not send out streamers. Older colonies are lobed, lobes not deeply incised, with short lines radiating towards the circumference. There are also

some longer, wavy lines nearer the circumference, and at right angles to it. The incisions of the lobes, while not deep, are yet continued as linear depressions almost to the centre, thus producing the appearance of folds.

The appearance in artificial solutions is, also, somewhat different, as is shown below:

With KNO_3—B. New Jersey—Moderately turbid, slight deposit.
" " " " " var.—Strongly turbid deposit, bubbles.
" KNO_2—B. New Jersey—Turbid, slight deposit.
" " " " " var.—Turbid deposit, layer on surface, bubbles.
" NH_4Cl—B. New Jersey—Turbid, brownish deposit.
" " " " " var.—Turbid, brownish deposit, layer on surface.
" Peptone—B New Jersey—Moderate turbidity, slight deposit.
" " " " " var.—Moderate turbidity, slight deposit.
" no nitrogen—B. New Jersey—Slight turbidity.
" " " " " " var.—Slight turbidity.

When tested a few days later with diphenylamine there was no reaction in either the nitrate or nitrite tubes. Further differences were observed in ordinary bouillon, where B. New Jersey var. shows very often a tendency to form a pellicle on the surface of the medium, while B. New Jersey shows no such tendency.

The Isolation and the Cultural Characteristics of Symbiotic Denitrifying Bacilli 20 and 21.

These two organisms were isolated from cow manure, and, until further study of them is made, will be called by their laboratory numbers, B. 20 and B. 21. B. 21 resembles greatly B. denitrificans, described by Burri and Stutzer,[1] which, in symbiosis with B. coli commune, is capable of destroying nitrates with the evolution of free nitrogen. B. 21 is entirely distinct from B. coli or B. typhosus, which can take its place in symbiotic denitrification, as will be seen by the cultural characteristics presented here. A discussion of the physiology of symbiotic denitrification and its distinction from other denitrification processes will be given below. In this place it need only be said that the two organisms are not capable of destroying nitrates when growing alone.

[1] Centr. f. Bact, part II., vol. I. (1895), p. 257.

For the purpose of isolation of denitrifying bacteria, .3 per cent. nitrate bouillon was inoculated with a bit of cow manure obtainued on the College Farm. In eighteen hours there was a copious evolution of nitrogen, as evidenced by the numerous minute bubbles rising to the surface and forming there a layer of foam. After one or two reinoculations, agar plates were prepared, and in three days, at the room temperature, there were at least three distinct organisms apparent, according to the appearance of the colonies:

1. Smooth, spreading, flat, skin-like, entire, with edges sharply cut.
2. Yellowish-white, thick, raised, irregular, glistening colonies.
3. Spreading, flat, glistening, irregular, warty colonies.

The last appeared in greater numbers than the others. On inoculating them into nitrate bouillon, none proved capable of denitrification. On making new plates from fermenting nitrate bouillon tubes, there were observed among the others flat, thin, fibrous colonies, which, on being inoculated into nitrate bouillon, showed, in some cases, at least, active denitrification. Plates prepared from the latter showed at least two kinds of colonies; one, the branched, thin, fibrous colonies, the other, thin, irregular, spreading colonies, with edges sharply cut and growing very rapidly. Because of the absence of the characteristic B. coli colonies, it was not thought at the time that there was a case of symbiotic denitrification at hand. It was soon noticed, however, that not all inoculations from the fibrous colonies, which were at first believed to be the denitrifying organisms, produced denitrification, and that the plates from the tubes which did ferment invariably contained two organisms. The second organism, producing the flat, spreading colonies, while it made its appearance somewhat later than the other, grew so rapidly as to cover the entire plate in two or three days, and made an uncontaminated inoculation almost impossible. Fresh agar plates were then prepared, and careful inoculations made from the fibrous colonies before the others became visible; and, similarly, nitrate-bouillon tubes were also inoculated from the flat, spreading colonies when they made their appearance. Out of the two tubes inoculated from the former there was no fermentation at all in one after ten days, and in the other, bubbles appeared on the fifth or sixth day instead of the normal twenty-four hours. On plating this second tube the two organisms were found, and it became clear that there was contamination in that tube. In the inoculations from the thin, flat,

spreading colonies no fermentation appeared. When, however, to one of these non-fermenting tubes a trace of bouillon was added from the tubes inoculated with the fibrous colonies, fermentation soon set in. In view of the fact that these organisms grew rapidly when alone, but produced no denitrification, and showed the same characteristics when reinoculated for several generations, and that when inoculation was made from one into the other, or when the two were inoculated at the same time into fresh nitrate bouillon, fermentation invariably set in, it was concluded that a case of symbiotic denitrification was here dealt with. Furthermore, plates prepared from each showed but one kind of colonies, which, when inoculated together, produced fermentation and produced none when kept separate.

Cultural Characteristics of B. 20.

AGAR COLONIES.

Deep colonies—white, small (less than 1 mm.), entire, irregularly round to elliptical. Surface colonies—slightly whitish and scarcely raised, very irregular, tufted and feathery, with very small, white centres. In some cases they have the appearance of fibrous, matted roots. Single colonies measure more than 1cm. across. In some smaller colonies the branches are wider at the tip.

NITRATE BOUILLON.

Turbid, almost white, film on surface very fine and slightly shimmering when held at the proper angle. Odor—none, or faint and unpleasant. In three days, a moderate white deposit.

BOUILLON.

In three days, turbidity and a slight white deposit.

NITRATE BOUILLON.

In three days, turbid, with a moderate white deposit.

AGAR STAB.

broad, tapering line of growth, reaching, in seven days, to
tom of the tube; growth on surface, whitish, scarcely raised,
ng, ultimately covering the entire surface.

AGAR STROKE.

th whitish, thin, glistening, covering entire surface, tufted at
condensation water turbid, with white deposit.

POTATO.

th slightly brownish band, somewhat raised and broader at
.

Cultural Characteristics of B. 21.

AGAR COLONIES.

small, round or elliptical, white, rather irregular and re-
g those of B. 20. Surface, spreading, thin, flat, skin-like,
r, attaining a diameter of several cm. if unimpeded in their
The edges are usually toothed or incised. The surfaces
bluish shimmer when held up to the light.

NITRATE BOUILLON.

rately turbid, violet, shimmering film rising some distance up
s of the tube, and tending to wrinkle when the tube is in-

BOUILLON.

ee days, slight deposit, turbidity, slight film.

NITRITE BOUILLON.

Turbid, moderate white, flaky deposit, fine bubbles rising to the surface, showing active fermentation.

AGAR STAB.

Tapering band of growth, narrower than in B. 20, extending not quite to the bottom of the tube; surface growth, white, glistening, irregular.

AGAR STROKE.

Irregular band of growth, wider at the base, outlines rather sharp and toothed, transparent, slightly whitish, condensation water turbid, with white, flaky deposit and film.

POTATO.

Band of growth brown, raised and covering about one-third of the surface.

FERMENTATION IN TUBES.

Abundant growth in lactose, glucose and saccharose bouillon, inoculated with either B. 20 or B. 21. In neither case was fermentation observed.

ODOR.

In the cultures of B. 20 scarcely any odor was noticed, and if any at all, a faint, unpleasant odor. In the cultures of B. 21 a distinct, rather pleasant odor.

BACTERIA IN ARTIFICIAL BOUILLON.

artificial bouillon was made up, as already described, of the salts and of sodium citrate and glucose; various sources of n were used, as with B. New Jersey. It was found that B. 20 21 showed striking differences in this respect, as the follow- ımns will show:

B. 20.

KNO_2 —Clear, no growth.
NH_4Cl — " " "
Peptone—Growth, turbidity, deposit.

B. 21.

KNO_2 —Heavy deposit, turbidity, shimmering film, nitrite reduced.
NHCl —Strong turbidity, waxy layer on surface, dirty white deposit, crystals on walls of tube.
Peptone—Heavy deposit, turbidity, shimmering film.

MORPHOLOGY.

B. 20.

rods, with rounded ends, occurring singly or in twos; length, icrons, with .5 microns. Stains uniformly with carbol fuchsin, h greater difficulty with the watery stains. There is no pro- motility in hanging drop, but many individuals showed vibra- tion.

B. 21.

short rods, with rounded ends, occurring singly or in twos. ke the polar stain with carbol fuchsin, and are .6–1.2 microns d .5–.6 microns wide. In hanging drop from either nitrite or agar, progressive motility is shown. The flagella are polar. he sake of comparison, the cultural characteristics of the two ic, denitrifying bacteria, B. coli commune and B. denitrifi- scribed by Burri and Stutzer,[1] are presented here.

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f. Bact., part II., vol. I., (1895), pp. 354–360.

B. Coli Communo.

FORM AND DIMENSIONS.

From two-days'-old gelatin plate—plump rods, with rounded ends, 1–1½ microns long and ¾ micron wide. From bouillon the organisms are larger, attaining a length of 2½ microns. The plasma is homogeneous and takes the stain easily and uniformly.

MOTILITY.

From fresh plates, very active, from bouillon, less so.

AGAR STAB.

Narrow growth, a long line of puncture in lower, as well as in upper portion. A round puncture on surface, a thin, skin-like glistening, smooth growth, soon extending to the walls of the tube.

AGAR STROKE.

Growth soft (slimy), strongly glistening, scarcely raised, with smooth, partly-toothed edges.

POTATO.

In two days, at 37° C., the characteristic moist, glistening growth of dirty-yellow color. The same at room temperature.

BOUILLON.

Evenly turbid, with a dirty-white deposit on the bottom of the tube, which easily breaks into fine particles on shaking. No pellicle on surface even after several weeks.

PIGMENT AND SPORES.

igment or spore formation noticed. Cultures several weeks ly sterilized by a single boiling.

FERMENTATION TUBES.

ding to Pflügge,[1] B. coli produces gas in lactose and glucose .

Cultural Characteristics B. of Denitrificans.

FORM AND DIMENSIONS.

rganisms are 1½–2½ microns long and ¾ micron wide. In cultures they may attain a length of 2–3 microns.

MOTILITY.

ly absent. Where present it is usually very active. In two d bouillon cultures (at 30° C.) the greatest part are non-

AGAR PLATES.

ce colonies, very thin, skin-like growth. There is a somewhat but not well-defined, portion in the centre. When only a onies are present on the plate they may attain in twenty-thirty hours, at 37° C., a diameter of 2 to 3 cm. The colonies ally roundish, but outgrowths occur, and where the colony on another, polygonal forms may arise.

AGAR STAB.

th in upper portion of stab more pronounced than in lower ; at times the growth does not extend along the entire length anal. On the surface there is a grayish fat, glistening deposit, n one or two days, reaches the walls of the tube.

-organismen.

AGAR STROKE.

Entire agar surface covered rapidly (at 30° C. in twenty-four hours) by a thin, grayish growth.

POTATO.

In two days, at room temperature, there is scarcely any growth. At 30° C., after two days, there is a 2 to 3 mm. wide band, glistening, scarcely raised, dirty brown-red, becoming more intensely colored in the following days. At room temperature the formation of pigment is less pronounced.

BOUILLON.

Becomes turbid, at 30° C., in twenty-four hours, to complete non-transparency, deposit reddish-white, which easily breaks up on shaking. No pellicle is formed, although a tendency in that direction is evidenced.

BEHAVIOR TOWARDS STAINS.

Water methyl violet colors the organisms readily, but not intensely. With carbol fuchsin there is an evident tendency to polar-staining. In single cases this is quite pronounced. Cultures on alkaline potatoes, at 37° C., produce a brown-red, variable pigment. Gelatine and agar show a dirty green fluorescence. No spore formation was observed.

By comparing B. 20 and B. 21 in the B. coli and with B. denitrificans, respectively, it will be observed that B. 20 and B. coli are distinct organisms, and that B. 21 and B. denitrificans show considerable differences, which make it appear that the two are not identical, and further study will be required to determine this point. Some further data as to the identity of B. 20 were obtained by comparing its growth in artificial bouillon with that of B. coli, a culture of which was secured through the kindness of Dr. Moore, of Cornell University.

WTH IN ARTIFICAL BOUILLON, WITH SOURCE OF NITROGEN, AS:

O_3—B. coli.—Turbid, film on surface.
B. 20—Clear, no growth.
O_2—B. coli.—Turbid, slight deposit.
B. 20—Clear, no growth.
$_4$Cl.—B. coli.—Turbid, flocculent, heavy deposit, film.
" B. 20—Clear, no growth.
tone—B. coli.—Turbid, white deposit, film.
" B 20—Growth, turbidity, deposit.

l be seen from the above that B. coli can grow very well in s containing the mineral salts, citrate and glucose, and either nitrite or an ammonium salt as its only source of nitrogen, . 20 could not grow at all under these conditions, but de- and grew rapidly in the same solution containing peptone as source of nitrogen. Ammonium chloride appeared to be a vorable source of nitrogen for B. coli than either potassium or potassium nitrite, and potassium nitrate appeared to be good as peptone. On the other hand, the growth with potas- rite as the only source of nitrogen was not as extensive.

e Carbon Compounds Best Suited for Denitrification.

tain amount of energy is required to tear apart the atoms in ate molecules. Unless such energy is at their disposal, the ying bacteria cannot effect the decomposition of nitrates. prophytic, they depend for their source of energy on organic ds, elaborated by the plant (or animal) world, yet there are ganic compounds which they prefer to others. The different ying bacteria thus far described show very considerable dif- in this respect. Lemmermann[1] has summed up the work of r of investigators up to 1900 on this particular point, and it ecessary to go into detail here. The work of Jensen, Stutzer tleb, Spieckermann, Stoklasa, Pfeiffer and Lemmermann is l by him, and to these should also be added the work of Stok- Vitek,[2] Massen[3] and Salzmann,[4] which appeared since the ion of Lemmermann's booklet. It seems that certain organic

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. 27.
f. Bact., part II., vol. VII. (1901), p. 257.
f. Bact., part II., vol. VIII. (1902), p. 152.
f. Bact., part II., vol. VIII. (1902), p. 347.

acids are a very suitable source of energy, carbohydrates, like fructose and glucose, are readily utilized by a number of denitrifying bacteria, as are some higher alcohols and amido derivations of the fatty acids. Spieckermann[1] obtained some interesting results with several series of organic compounds. He found that glucose could be utilized very readily by the four denitrifying bacteria with which he worked, and namely, B. pyocyaneus B., B. fluorescens liquefaciens and two denitrifying organisms which he islolated from manure, but which he has not described.

In a series of solutions containing, besides the mineral salts, per cent. of—

Glycerin—CH_2OH, $CHOH$, CH_2OH.
Glycerose—CH_2OH, $CHOH$, CHO.
Glyceric acid—CH_2OH, $CHOH$, $COOH$.
Tartronic acid—$COOH$, $CHOH$, $COOH$.

He found that there was no growth at all in glycerose and tartronic acid, and growth and denitrification in the solution of glyceric acid and glycerin, in the former, however, only by B. pyocyaneus and B. fluorescens liquefaciens. On examining the clear solution of glycerose, he found that the bacteria had been destroyed there, while in the tartronic acid the bacteria were still capable of development when placed in a glucose solution. It appears from this that the aldehyde glycerose acted as a poison to all organisms, and that tartronic acid, differing from glyceric acid by the replacement of the carboxyl group by CH_2OH did not offer a suitable source of energy to the denitrifying organisms. Still greater individual peculiarities were observed in the following series:

$$\left.\begin{array}{l}\textbf{Mannit}\ldots\ldots\\ \textbf{Sorbit}\ldots\ldots\\ \textbf{Dulcit}\ldots\ldots\end{array}\right\} CH_2OH\ (CHOH)_4\ CH_2OH$$

$$\left.\begin{array}{l}\textbf{Glucose}\ldots\ldots\\ \textbf{Fructose}\ldots\ldots\\ \textbf{Galactose}\ldots\ldots\end{array}\right\} CH_2OH\ (CHOH)_4\ CHO.$$

$$\textbf{Muric acid}\ldots \} COOH\ (CHOH)_4\ COOH.$$

The results obtained were as follows:

Mannit—Complete denitrification by the four organisms in three days.

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[1] Lemmermann, l. c., p. 28

Sorbit—No growth by B. pyocyaneus and B. fluorescens liquefaciens, while the two organisms isolated by him from manure destroyed the nitrate completely in three days.

Dulcit—No growth by B. pyocyaneus and B. fluorescens liquefaciens; complete denitrification by the others in four days.

Glucose—Complete denitrification by all in four days.

Fructose—Complete denitrification by all in three days.

Galactose—Complete denitrification by all except B. fluorescens liquefaciens in three days; the latter failed to grow.

Mucic acid—No growth by any of the four.

In this case the aldoses glucose and galactose seemed to be favorable sources of carbon, as was the ketose fructose. The higher alcohols also proved suitable, yet two of the organisms failed to grow in sorbit and dulcit. The two carboxyl groups of the mucic acid inhibited growth, also, in this case. It is not likely that the cause of the failure lies in the *number* of carboxyl groups present, for citric acid, which contains three carboxyl groups, has been found to be, also, in this laboratory, a very suitable source of carbon, and it must be assumed that it 's the *position* of the carboxyl group in mucic or tartronic acid which enders these compounds an unfavorable source of energy. Spieckernann found, also, amido-acids, and hydroxy acids to be favorable ources of carbon. Of the acids of the paraffine series, formic and cetic acids proved unsuitable, while propionic, butyric, isobutyric, vaerianic and capronic could be utilized by all four organisms. Spieckrmann also tried saturated and unsaturated alcohols and a number f pentoses. According to Stoklasa,[1] a considerable number of denitifying bacteria can make use of butyric, succinic, malic, lactic and itric acids, and also d-glucose, l-xylose, l-arabinose, saccharose, ıaltose and lactose for their development. Among the organisms hich he ennumerates is, also, B. pyocyaneus, but the work in this boratory indicates that B. pyocyaneus is not capable of utilizing l of the substances mentioned by him, as will be shown below.

Salzmann[2] studied the behavior of B. Hartlebi and B. Stutzeri wards the carbon compounds, and he also found distinct individual culiarities. Thus, B. Hartlebi could utilize saccharic and formic id, while B. Stutzeri was unable to do that. Furthermore, it was ıable to make use of arabinose, xylan, glucose, inulin, lactose and

[1] Centr. f. Bact., part II., vol. VII. (1901), p. 257.

[2] Dissertation, Königsberg (1901), Abstr. in Centr. f. Bact., part II., vol. VIII., p. 347.

maltose, while B. Hartlebi developed in solutions of these without difficulty. B. Stutzeri was also unable to utilize mannit, isoamyl and isobutyl alcohols, which proved suitable for B. Hartlebi. The latter could also make use of hippuric and uric acid, which was not true of B. Stutzeri,

Behavior of B. New Jersey Towards Organic Acids.

In order to determine the comparative value of several organic acids as a source of carbon for B. New Jersey, a solution of mineral salts was prepared, which contained, per liter:

2 grams	$Mg\ So_4$
2 "	$K_2\ H\ Po_4$
0.2 "	$Ca\ Cl_2$
2 "	$K\ No_3$
2 drops of	$Fe_2\ Cl_6$

As the source of carbon there, as added in the different cases, succinic, tartaric, lactic or citric acid, all at the rate of 5 gr. per liter, and in some cases asparagine, at the rate of 2 gr. per liter. The arrangement of the experiment was as follows:

1. Mineral salts + lactic acid.
2. " + " + $Ca\ Co_3$
3. " + " + Asparagine.
4. " + " + " + $Ca\ Co_3$

5. Mineral salts + succinic acid.
6. " + " + $Ca\ Co_3$
7. " + " + Asparagine.
8. " + " + " + $Ca\ Co_3$

9. Mineral salts + tartaric acid.
10. " + " + $Ca\ Co_3$
11. " + " + Asparagine.
12. " + " + " + $Ca\ Co_3$

13. Mineral salts + citric acid.
14. " + " + $Ca\ Co_3$
15. " + " + Asparagine.
16. " + " + " + $Ca\ Co_3$

The calcium carbonate, where used, was added at the rate of .5 gr. to each flask, which contained, in every case, 200 cc. of liquid. The different acids in solution were neutralized with sodium hydroxide until they were faintly alkaline to phenolphtaleine, the degree of

nity being nearly the same in every case. After the 200 cc. ns of the respective solutions were placed in the corresponding the latter were plugged with cotton stoppers and sterilized in toclave. After sterilization it was discovered that the potassium e was omitted in flasks 1, 2, 3 and 4; nevertheless, the inocula- ras proceeded with, it being deemed inadvisable, at the time, ke up new solutions. After inoculation with B. New Jersey the l flasks were placed in the incubator and kept at 28° C. In ays the following was observed:

'lask 1. Clear.
" 2. "
" 3. Turbid.
" 4. " flaky deposit.

" 5. Clear.
" 6. "
" 7. Turbid, flaky masses and skin-like membrane.
" 8. " " " more limited

" 9. Clear.
" 10. "
" 11. Turbid, dirty white deposit, bubbles.
" 12. " " " " copious bubbles.

" 13. Turbid, flaky deposit.
" 14. " " "
" 15. " liquid yellowish, bubbles.
" 16. " copious bubbles, deposit.

ving the lactic acid out of consideration, it appears that only acid proved suitable as a source of energy when used alone, 5, 6, 9 and 10 remained clear and showed no growth, while, other hand, citric acid, in 13 and 14, without the addition of her organic compound, proved efficient as a source of carbon. 4, 7, 8, 11, 12, 15 and 16, where asparagine was also added, was rapid growth, with the ultimate disappearance of the s, and furthermore, where calcium carbonate was added, there eater development; thus, in 12 and 16 there was a more in- growth than in the corresponding 11 and 15, where no calcium ate was used. It was also observed that bubbles first appeared and 16, then in 7 and 8, and finally in 11 and 12. In fifteen fter inoculation the several flasks appeared as follows:

1. Clear.
2. Cloudy.
3. Turbid, floating pellicles, dirty white deposit.
4. " " " deposit more abundant.

5. Clear.
6. Turbid, some deposit.
7. Moderately turbid, liquid yellowish, flaky deposit.
8. Turbid, bluish-white layer along walls of flask, deposit more abundant.

9. Clear.
10. "
11. Turbid, deposit paraffine like.
12. Clear, deposit more abundant.

13. Turbid, large bubbles, slight deposit.
14. " " " deposit.
15. " liquid pinkish, crystalline deposit, paraffine-like particles on surface.
16. Turbid, liquid pinkish, crystalline deposit, paraffine-like particles on surface.

It will be noticed here that in flask 6, where succinic acid was used as the only source of carbon, there was growth, while there was none in flask 5, showing that the presence of calcium carbonate allowed B. New Jersey to utilize succinic acid. There was a slight cloudiness in 2, indicating a very limited growth, and probably due to the trace of combined nitrogen contained in the reagents. It has been found, in other experiments, that lactic acid is a very suitable source of carbon to many denitrifying bacteria. Tartaric acid alone proved altogether unsuitable for B. New Jersey. After sterilization the several cultures were filtered and the nitrogen in the insoluble residue on the filters determined, according to the Kjeldahl method, with the following results:

Insoluble organic	N	in No.	1—0	mg.	Insoluble organic	N	in No.	9—0	mg.
"	"	"	2—0.3	"	"	"	"	10—lost	"
"	"	"	3—2.38	"	"	"	"	11—4.77	"
"	"	"	4—1.83	"	"	"	"	12—8.30	"
"	"	"	5—0	"	"	"	"	13—2.20	"
"	"	"	6—0 96	"	"	"	"	14—2.00	"
"	"	"	7—1.93	"	"	"	"	15—7.84	"
"	"	"	8—4.22	"	"	"	"	16—9.18	"

The quantities of nitrogen recovered as insoluble organic were, with one exception, greater in the samples where calcium carbonate was used, as against the corresponding samples where none was employed. There were 9.18 mg. of nitrogen found as insoluble organic in

16, as against 7.84 mg. in 15; 8.30 mg. were found in 12, as against 4.77 mg. in 11, and 4.22 mg. were found in 8, as against 1.93 mg. in 7. The favorable influence of calcium carbonate is also observed in 2, as compared with sample 1, and in sample 7, compared with sample 6. The amount of insoluble organic nitrogen found is proportionate to the development of the bacteria, although, as far as denitrification proper is concerned, the losses are not necessarily greatest where the amount of insoluble organic nitrogen formed is the greatest. On the contrary, where the decomposition of the nitrates takes place more slowly, more ammonia is formed and more of the nitrate nitrogen is utilized to build up the bodies of the bacteria. In 1, 5 and 9, where no growth took place, no insoluble organic nitrogen was found, and, strangely enough, .3 mg. were found in 2, where no nitrogen was added to the solution. It may be that traces of nitrogen were present in the reagent (they could not have been more than traces), yet, admitting that, it is scarcely possible that the 3 mg. were all derived from the reagents, for the blank determinations would have showed the presence of 3 mg. of nitrogen. It is more likely that the organisms obtained part of this nitrogen from the air, as will be shown to have occurred in other experiments reported here. It is significant that in 1, without the addition of $CaCo_3$, such limited fixation of atmospheric nitrogen did not take place. Comparing the structural formulas of lactic, succinic, tartaric and citric acids, we find the following relations:

Lactic......C_2H_4 (OH) COOH	**Tartaric....C_2H_2 $(OH)_2$ $(COOH)_2$**
Succinic....C_2H_4 $(COOH)_2$	**Citric.......C_3H_4 (OH) $(COOH)_3$**

Succinic acid was evidently a better source of carbon than tartaric acid, but the two are closely related, the latter being derived from the former by the replacement of two hydrogen atoms by hydroxyl groups. The tribasic citric acid and the monobasic lactic acid are also hydroxy acids, yet they are better sources of carbon than either succinic or tartaric acid.

Further studies in this direction were carried out in another experiment, where, besides B. New Jersey, also B. pyocyaneus was used. A nutrient solution was prepared, containing, per liter, .2 gr. $MgSo_4$, .2 gr. K_2 HPO_4, .02 gr. $CaCl_2$, and 2 gr. KNO_3. Besides these, there was added in each case some organic compound at the rate of 5 gr. per liter to serve as the source of energy. Where organic acids were used, sodium hydroxide was added to a faintly alkaline reaction to phenolphtaleine, so that the sodium salt of the respective acid was

really used. In the case of citric acid, ho
used instead of sodium citrate, and calcula
of citric acid per liter. Two hundred cc.
placed in 500 cc. Erlenmeyer flasks, 5 gr.
and sterilized in the autoclave. After ste
added to certain flasks at the rate of 2 gr.
ized in the Arnold sterilizer. Pure filter
was used as the source of cellulose. The a
ment was as follows:

1. Inorganic solution, + sterile.
2. " " + B. New Jersey.
3. " " + citrate, B. New
4. " " + cellulose, " "
5. " " + dextrin, " "
6. " " + starch, " "
7. " " + glucose, " "
8. " " + lactose, " "
9. " " + saccharose, " "
10. " " + maltose, " "
11. " " + asparagine, " "
12. " " + citrate + asparagine
13. " " + cellulose + "
14. " " + dextrin + "
15. " " + starch + "
16. " " + glucose + "
17. " " + lactose + "
18. " " + saccharose + "
19. " " + maltose + "
20. " " + asparagine sterile.
21. " " + citrate, B. pyocyane
22. " " + cellulose, "
23. " " + dextrin, B. "
24. " " + starch, "
25. " " + glucose, "
26. " " + lactose, "
27. " " + saccharose, "
28. " " + maltose, "
29. " " + asparagine, "
30. " " + citrate + asparagine
31. " " + cellulose + "
32. " " + dextrin, "
33. " " + starch + "
34. " " + glucose + "
35. " " + lactose + "
36. " " + saccharose + "
37. " " + maltose + "
38. " " + citrate, B. New Jers

In four days after inoculation the following observations were made:

1 to 5 inclusive, clear.	24. Cloudy.
6 to 9 inclusive, cloudy.	25. "
10. Signs of growth.	26. Clear.
11. Turbid, bubbles appearing.	27. "
12. " " large.	28. Cloudy.
13. " "	29. " a few bubbles.
14. " "	30. Turbid, bubbles.
15. " "	31. " "
16. Clear.	32. " "
17. " signs of growth.	33. " "
18. Turbid, bubbles.	34. " "
19. Clear.	35. Faintly cloudy.
20. "	36. Turbid, bubbles.
21. Cloudy.	37. " "
22. Clear.	38. Faintly cloudy.
23. Cloudy.	

A comparison of the solutions inoculated with B. New Jersey with those inoculated with B. pyocyaneus reveals the fact that the latter organism can make use of a greater variety of organic substances for its development. In four days B. New Jersey produced scarcely any growth in the flasks where asparagine had not been added, and even in the latter the growth was not constant. With B. pyocyaneus there was growth in every flask where asparagine had been added, and signs of growth in some of the others. In eight days the appearance of the several flasks was as follows:

One to 5, inclusive, clear; 6, cloudy; 7 to 10, inclusive, clear; 11 to 16, inclusive, turbid and bubbles; 17, clear; 18, turbid; 19, 20, 22, 24, 26 and 27, clear; 21, 23 and 25, cloudy; 28 to 37, inclusive, bubbles, fermentation, probably complete; 38, slightly cloudy. Three days later 6 was found to be turbid, and 21, 23 and 25 showed farther growth. In two weeks, also, 3 showed vigorous growth, and fermentation was observed in 21, 23 and 25. From this time no essential changes were observed through the summer. At the end of four months the cultures were tested for nitrates and nitrites, with the following results:

Nitrates and nitrites absent in 3, 12, 14, 15, 16, 17, 18, 21, 25, 30, 34 and 37. In the other cases diphenylamine gave a more or less pronounced reaction. B. New Jersey destroyed the nitrate completely in the presence of citrate alone, but did not do so with asparagine alone, nor with asparagine and cellulose together, and not even with asparagine and maltose together. B. pyocyaneus, on the other hand, could make use of glucose alone for the destruction of the nitrate, but did not cause complete denitrification, as did B. New Jersey in

the presence of dextrin and asparagine, starch and asparagine, lactose and asparagine, saccharose and aspargine. Like B. New Jersey, it caused complete denitrification with glucose and asparagine; and unlike B. New Jersey, it caused complete denitrification with maltose and asparagine.

The cultures were sterilized and filtered, and the insoluble organic nitrogen left on the filter determined. After subtracting from the several determinations the amount of nitrogen found in the blanks, the following quantities were obtained:

Insoluble Organic Nitrogen.

1......	..... mg.	11......	2.0 mg.	21......	1.5 mg.	31......	6.7 mg.
2......	..... "	12.....	1.8 "	22.....	..... "	32......	4.5 "
3.....	.4 "	13......	1.6 "	23......	..... "	33.....	9.1 "
4......	..... "	14......	1.3 "	24.....	.9 "	34.....	1.7 "
5......	..... "	15......	6.4 "	25......	.5 "	35......	8.2 "
6......	4.0 "	16......	1.7 "	26......	..... "	36.....	9.0 "
7......	..... "	17......	..... "	27......	..... "	37......	8.0 "
8......	..... "	18......	1.9 "	28......	1.9 "	38......	... "
9......	..... "	19......	..... "	29.....	6.8 "		
10......	.6 "	20......	..... "	30......	9.9 "		

The two organisms again display here an individuality of their own; notwithstanding this, they show common characteristics. B. New Jersey has not, on the average, shown as much development as B. pyocyaneus, as is indicated by the subjoined figures:

B. NEW JERSEY.		B. PYOCYANEUS.	
Citrate........................	.4 mg.	Citrate........................	1.5 mg.
Starch........................	4.0 "	Starch........................	.9 "
Maltose........................	.6 "	Glucose........................	.5 "
Asparagine........................	2.0 "	Maltose........................	1.9 "
Citrate + asparagine......	1.3 "	Asparagine........................	6.8 "
Cellulose + "	1.6 "	Citrate + asparagine......	9.9 "
Dextrin + "	1.3 "	Cellulose + "	6.7 "
Starch + "	6.4 "	Dextrin + "	4.5 "
Glucose + "	1.7 "	Starch + "	9.1 "
Saccharose + "	1.9 "	Glucose + "	1.7 "
		Lactose + "	8.2 "
		Saccharose + "	9.0 "
		Maltose + "	8.0 "

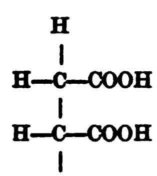
B. New Jersey has developed with an appreciable production of insoluble organic nitrogen in ten cases, and B. pyocyaneus in thirteen cases. The average amount in the former case was 2.12 mg., and in

the latter 5.28 mg. With citrate B. New Jersey effected a complete destruction of the nitrate with the formation of only .4 mg. of insoluble organic nitrogen, while B. pyocyaneus produced, under the same circumstances, 1.5 mg. of insoluble organic nitrogen, and since that nitrogen is contained in the bodies of the bacteria, it must be concluded that either the body substance of B. New Jersey is poorer in nitrogen, or that B. pyocyaneus must be present in greater numbers in order to destroy the same amount of nitrate. With starch alone there was considerable growth, both with B. New Jersey and B. pyocyaneus, but in the former case more insoluble organic nitrogen was formed, and in neither case was there a complete destruction of the nitrate. B. New Jersey showed scarcely any growth with maltose, although some insoluble organic nitrogen was formed, and a larger amount was formed by B. pyocyaneus. A complete reduction of the nitrate was not effected in either case. With asapargine alone B. New Jersey produced 2 mg. of insoluble organic nitrogen, and B. pyocyaneus 6.8 mg. With citrate and asparagine B. New Jersey produced 1.3 mg. of insoluble organic nitrogen, and effected a complete reduction of the nitrate under similar conditions; B. pyocyaneus produced 9.9 mg. of insoluble organic nitrogen, with the complete reduction of the nitrate. With cellulose and asparagine B. New Jersey produced 1.6 mg. of insoluble organic nitrogen, without completely reducing the nitrate, while B. pyocyaneus produced 6.7 mg. of insoluble organic nitrogen and destroyed the nitrate completely. With dextrine and asparagine B. New Jersey effected complete denitrification, with the formation of 1.3 mg. of insoluble organic nitrogen, while B. pyocyaneus produced 4.5 mg. under the same conditions, but did not destroy the nitrate completely. Similar relations hold true in the case of starch and asparagine—B. pyocyaneus producing more insoluble organic nitrogen and exerting a more limited denitrifying action. In the case of asparagine and glucose a complete reduction of the nitrate was effected in both cases, with the production of the same amount of insoluble organic nitrogen. This indicates that glucose is a very suitable substance for B. pyocyaneus for the destruction of nitrate. No growth at all took place in asparagine and lactose inoculated with B. New Jersey, while the same solution inoculated with B. pyocyaneus there was abundant growth. From other experiments it was also found that while the salts of citric acid are a very suitable source of carbon for B. New Jersey, and the salts of lactic acid not as suitable, B. pyocyaneus takes very kindly to the latter. B. New Jersey produced no growth in maltose and asparagine; B.

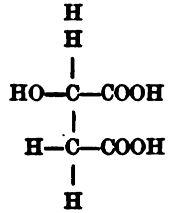
pyocyaneus produced 8 mg. of insoluble organic nitrogen, and effected a complete destruction of the nitrates.

These facts again prove that the development of the denitrifying bacteria is not necessarily proportionate to their denitrifying power. On the one hand, there may be considerable growth and development with scarcely any reduction of the nitrate present in the solution; on the other hand, there may be a comparatively limited growth, accompanied by the complete reduction of the nitrate. Salzmann has noticed[1] a similar relation of the bacteria to the organic substance serving as the source of carbon. Working with B. Stutzeri, he found that certain carbon compounds like oxalic acid—isobutyl, isoamyl and amylalcohol—while they allowed the growth of the bacteria, did not enable the latter to carry the reduction farther than the nitrite stage. In other cases B. Stutzeri produced more or less growth without causing denitrification, this being true of solutions which contained formic, oxalic or saccharic acid, glucose, arabinose, lactose, maltose, inulin, xylan or uric acid.

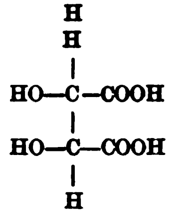
Still another experiment, to study the comparative value of succinic, malic and tartaric acid as a source of carbon, was arranged. This series was of particular interest, because there is a gradual transition here from the dibasic, succinic acid to the dioxy-dibasic tartaric acid, as follows:



Succinic acid.



Malic acid.



Tartaric acid.

[1] Dissertation, Königsberg (1901), Abstr. in Centr. f. Bact., part II., vol VIII., p. [illegible].

Three organisms were used for inoculation, and namely, B. New Jersey, B. coli and B. subtilis, and the experiment was arranged in the following order:

1.	**Inorganic solution**		+	**succinic acid, sterile.**					
2.	"	"	+	"	"	**inoc., B. New Jersey.**			
3.	"	"	+	"	"	"		"	"
4.	"	"	+	**malic acid, sterile.**					
5.	"	"	+	"	"	**inoc.,**		"	"
6.	"	"	+	"	"	"		"	"
7.	"	"	+	**tartaric acid, sterile.**					
8.	"	"	+	"	"	**inoc.,**		"	"
9.	"	"	+	"	"	"		"	"
10.	"	"	+	**succinic**	"	**inoc , B. coli.**			
11.	"	"	+	"	"	"	"		
12.	"	"	+	**malic acid,**		"	"		
13.	"	"	+	"	"	"	"		
14.	"	"	+	**tartaric acid,**		"	"		
15.	"	"	+	"	"	"	"		
16.	"	"	+	**succinic**	"	"	**B. subtilis.**		
17.	"	"	+	"	"	"	"		
18.	"	"	+	**malic**	"	"	"		
19.	"	"	+	"	"	"	"		
20.	"	"	+	**tartaric**	"	"	"		
21.	"	"	+	"	"	"	"		

The inorganic solution was made up as in the above experiments, calcium carbonate was added in each case and the alkalinity was made —.1, to phenolphtaleine. The organic acids, added at the rate of 5 gr. per liter, were ultimately presented to the bacteria as the corresponding sodium salts. Potasium nitrate was used as the only source of nitrogen, at the rate of 2 gr. per liter. In each flask there were 200 cc. of solution. After inoculation the cultures were kept in the incubator at 28° to 30° C. In about four weeks after inoculation the following observation was made:

1	**Clear.**	**12**	**Somewhat cloudy.**
2	"	**13**	" "
3	"	**14**	**Clear.**
4	"	**15**	"
5	"	**16**	"
6	**Turbid, bubbles.**	**17**	"
7	**Clear.**	**18**	"
8	"	**19**	"
9	"	**20**	"
10	"	**21**	"
11	"		

After four months the appearance of the respective flasks was not changed much. Five and 6 showed large bubbles; 10 and 11, 12 and 13, while they showed no bubbles, indicated considerable growth. The flasks were then sterilized in the autoclave and filtered. The nitrogen determinations in the material on the filter corresponded with the appearance of the cultures. The amounts of insoluble organic nitrogen found were in—

5............1.7 mg.	10............1.6 mg.	12..............0.4 mg.
6............ 1.4 "	11. ....1.7 "	13..............1.8 "

In the other flasks there was no apparent growth, and no insoluble organic nitrogen was found. Of the three acids presented to B. New Jersey, malic acid proved suitable for complete denitrification, while the other two were not available. B. coli could make use of both succinic and malic acid for its development, yet there was not in any of these cases a complete destruction of the nitrate, but only a reduction to nitrate, quanitative determinations showing more than 80 per cent. of the original nitrate nitrogen converted into nitrite nitrogen. The amounts of insoluble organic nitrogen formed by B. coli show some discrepancies. Thus, in 12 we find only .42 mg. of insoluble organic nitrogen, while in the parallel, 13, we find 1.8 mg. Apparently, we have to deal here with cultural peculiarities not thoroughly understood. B. subtilis showed no growth at all and no production of insoluble organic nitrogen. Here we have three organisms, one of which developed in the presence of malic acid, with the complete destruction of the nitrate; another developed both in malic and succinic acid, with the far-reaching reduction of nitrate to nitrite, and the third organism, which could not derive its energy from any of the three organic acids.

A close insight into the nature of denitrification would enable us to account for these peculiarities. As the matter stands at present the various explanations which have been offered do not account for all of the phenomena observed. It is true that the students of the subject agree almost unanimously that the partial or complete exclusion of oxygen favors denitrification, and that a thorough aeration retards it, or stops it completely; yet this knowledge does not help us to understand how the oxygen is withdrawn from the nitrate. It would not be out of place, perhaps, to state here that in the literature of denitrification, some cases, at least, are known where thorough aeration rather favors than retards denitrification. Such an observation

ıade by Stoklasa[1] in regard to B. megatherium, which caused rapid reduction of nitrite in solutions thoroughly aerated and ning either xylose or arabinose as the source of energy. In days, at 28° C., there was a loss of 59.89 per cent. of the en originally present in the solution. Apart from this fact and others the evidence is all in favor of the view stated above, y, that the partial or complete exclusion of oxygen favors the ion of nitrates.

as been found that in solutions containing the nitrogen in some form than nitrate, the denitrifying bacteria develop readily in contact with the air, but that they do not develop when the oxygen is excluded. It has been found that in similar solu- containing nitrate the bacteria develop and destroy the nitrate he evolution of free nitrogen, even when the air or oxygen is ed; in fact, the growth of the denitrifying organisms is fav- y anaerobic conditions of the experiment. It has been found, ver, that the denitrifying bacteria can grow in solutions con- g nitrate without reducing the latter, provided that air or ı is passed through the solution, or, better still, when the in- ed medium is spread out in a very thin layer, thus presenting surface to the oxygen.[2] All these facts indicate that it is the ı of the nitrate which plays the important part in their reduc- Additional evidence in favor of this view is brought forward issenberg,[3] who believes that his contention is proved by the ing simple experiment: Four 10 cc. lots of bouillon were pre- part of them containing .25 per cent. of sodium nitrite, inocu- with B. pyocyaneus and kept for three days at 37° C.

Tube with 10 cc. of bouillon and without nitrite, anaerobic. , no growth, or, at best, very insignificant.

Tube with 10 cc. of bouillon, containing nitrite, anaerobic. , excellent growth, active fermentation. Disappearance of the .

Two hundred cc. flask, containing only 10 cc. of nitrite bouil- robic. Result, excellent growth but no fermentation. Nitrite ning.

As in *c*, but anaerobic. Result, excellent growth and fer- tion. Disappearance of the nitrite.

r. f. Bact., part II., vol. IV. (1898), p. 287.
mermann, l. c., pp. 37–53.
tr. f. Bact., vol. VIII. (1902), p. 166.

Maassen found that the addition of chlorate diminishes denitrification without otherwise influencing the growth of the denitrifying bacteria, but that the reduction of the nitrate to nitrate still takes place. This, again, is in line with the claim of Weissenberg[1] that the reduction of nitrate to nitrite, and the reduction of nitrite with the evolution of free nitrogen, are entirely distinct processes. B. Actinopelte, isolated by Baur,[2] shows some striking peculiarities. It is not capable of destroying nitrites in pure nitrite bouillon, but is capable of denitrification when growing together with other bacteria, or when growing in solutions where other bacteria had been growing and had been killed by sterilization, or when certain carbohydrates were added to the solution. When recently isolated B. Actinopelte could destroy nitrates, as well as nitrites, with the evolution of free nitrogen, but it gradually lost the power of reducing nitrates to nitrites, although it still retained the power (to a very limited extent) to destroy nitrites. Baur also thinks that the nitrites are destroyed by B. Actinopelte, because of its oxygen requirements. This organism can develop under anaerobic conditions, but grows better in nitrite containing media than in nitrite free media. The access of oxygen favors the denitrification, and this is also true of B. lobatum, another organism isolated by Baur. Evidently we have to deal here with individual peculiarities, which render the problem more complicated. Unfortunately the original article is not at hand, and from the abstract referred to it would seem that the author contradicts himself. On the one hand, we are told that the nirite is destroyed because of the oxygen requirements of the bacteria, and on the other that the access of oxygen favors denitrification—that is, the destruction of nitrite. The greater amount of experimental evidence, as noted above, indicates that the free access of oxygen diminishes the destruction of the nitrates, which is not in accord with Baur's observations.

The Transformation of the Nitrogen in Nitrate Bouillon.

The organisms employed in this experiment were B. coli commune. B. cholera suis, proteus vulgaris, B. subtilis and B. pyocyaneus, obtained from the bacteriological laboratories at Cornell University. In each case inoculation was made into tubes containing 10 cc. of sterile

[1] Lemmermann, l. c., p. 38.

[2] Centr. f. Bact., part II., vol. VIII. (1902), p. 538.

nitrate bouillon. The experiment lasted twenty-eight days, and its arrangement and results were as follows:

	Insoluble Organic N.	Ammonia N.	Nitrate N.	Total N.
1. Sterile	......	......	1.020 mg.	23.88 mg.
2. B. coli	.401 mg.	1.842 mg.	.199 "	21.02 "
3. B. coli	.401 "	1.083 "	.219 "	18.38 "
4. B. cholera suis	......	......	.205 "	19.48 "
5. B. cholera suis	......	......	.205 "	19.48 "
6. Proteus vulgaris	1.129 "	4.011 "	.121 "	18.71 "
7. Proteus vulgaris	.976 "	4.335 "	.141 "	18.38 "
8. B. subtilis	.687 "	4.662 "	Lost.	18.93 "
9. B. subtilis	.542 "	4.986 "	1.030 "	19.26 "
10. B. pyocyaneus	1.518 "	3.684 "	.150 "	15.96 "
11. B pyocyaneus	1.012 "	4.011 "	.135 "	15.95 "

The amounts of insoluble organic nitrogen produced by the different bacteria were variable, the greater quantity being formed by B. pyocyaneus; B. cholera suis produced very slight growth, with practically no insoluble organic nitrogen. The amount of insoluble organic nitrogen formed by B. coli was comparatively small. In the case of ammonia the relations are somewhat different. The greatest quantity was found in the cultures of B. subtilis and the next greatest in the cultures of proteus vulgaris. The ammonia found in the cultures of B. cholera suis was practically nil. It will be noticed that the nitrates were diminished in amount in every case except in that of B. subtilis, where the amount found was nearly the same as that found in the sterile tube. This is rather strange, in view of the fact that B. subtilis had been reported by several investigators as capable of reducing nitrates. Comparing the quantities of total nitrogen as found by analysis, it will be noticed that there was less nitrogen present at the end of the experiment than was found in the sterile tube. The greatest loss was caused by B. pyocyaneus, almost 8 mg. out of the 23.83 mg. orginally present. B. cholera suis, although it produced but slight growth, caused, nevertheless, a loss of nitrogen. The parallels in B. coli showed considerable differences; in one of them there was much more ammonia found than in the other, and the total nitrogen found was also greater in amount. Proteus vulgaris caused a smaller loss of nitrogen than did B. subtilis, although the differences are not great. In view of the comparatively large amounts of ammonia formed, it would seem that the losses of nitrogen may have occurred by the volatilization of the ammonia rather than by the evo-

lution of free nitrogen from the nitrate. This belief is strengthened by the fact that the largest quantity of ammonia was produced by B. subtilis, and yet there was no reduction of the nitrate in this case.

In a similar experiment, also, extending through twenty-eight days, the following results were obtained:

	Insoluble Organic N.	Ammonia N.	Nitrate N.	Total N.
1. Sterile...............	......	......	1.00 mg.	22.28 mg.
2. "	......	......	.95 "	22.28 "
3. B. coli...............	1.30 mg.	1.65 mg.	.16 "	17.83 "
4. B. cholera suis.....	.64 "	.64 "	.16 "	17.83 "
5. B. subtilis...........	...... "	3.18 "	.95 "	18.47 "
6. B. pyocyaneus.....	1.11 "	2.55 "	...... "	14.60 "
7. Proteus vulgaris..	1.02 "	3.44 "	.14 "	15.92 "

Also here the greatest loss of nitrogen was caused by B. pyocyaneus, although the amount of insoluble organic formed was not as great as formed by B. coli. Practically no insoluble organic nitrogen was formed by B. subtilis, although it produced growth with the formation of the next greatest amount of ammonia. The nitrate was not affected, apparently, also, in this case. The loss of nitrogen caused by B. pyocyaneus was very considerable, more than one-third of the original amount having disappeared. Proteus vulgaris also caused a large loss of nitrogen, and it produced 3.44 mg. of ammonia, an even greater amount than that formed by B. subtilis. There was a diminution of nitrate in every case. B. pyocyaneus caused a complete disappearance of the nitrates; in the other cases most of it had vanished from whatever cause, with the exception already noted.

The Reduction of Different Nitrates by B. New Jersey var. and B. Pyocyaneus.

In order to determine the relative denitrification of the alkali and alkaline earth nitrates, an artificial solution was made up containing $K_2H\ PO_4$, Mg. SO_4, $CaCl_2$, $Fe_2\ Cl_6$, in the same quantities as in the other experiments. Calcium carbonate was also added to each flask, at the rate of 5 gr. per sample. The arrangement of the experiment was:

100 cc. of solution containing .2 gr. KNO_3—sterile.
" " " " " — "
" " " " " —B. New Jersey var.
" " " " " —B. pyocyaneus.
" " " .168 gr. $NaNO_3$—B. New Jersey var.
" " " " " —B. pyocyaneus.
" " " .079 gr. NH_4NO_3—B. New Jersey var.
" " " " " —B. pyocyaneus.
" " " .146 gr. $Mg(NO_3)_2$—B. New Jersey var.
" " " " " —B. pyocyaneus.
" " " .260 gr. $Ba(NO_3)_2$—B. New Jersey var.
" " " " " —B. pyocyaneus.
" " " .211 gr. $Sr(NO_3)_2$—B. New Jersey var.
" " " " " —B. pyocyaneus.

samples were sterilized in the autoclave, inoculated with the ponding bacteria and kept at room temperature. In four days llowing observations were made:

Clear, no growth.
" " "
Cloudy, sediment.
" " whitish, brittle layer on surface.
Very slightly cloudy, flaky precipitate.
Cloudy, heavy, whitish, brittle layer.
Moderately turbid, white patches on surface.
Cloudy, whitish, brittle layer, some large bubbles.
Moderately turbid, surface layer irregular in thickness, flaky deposit.
Heavy, white brittle layer, cloudy flakes.
Moderately turbid, copious, flaky deposit.
Bubbles on surface, whitish layer, liquid yellowish, turbid.
As in 11.
As in 12.

the presence of strontium and barium nitrate, B. pyocyaneus ced the characteristic golden yellow color, while it failed to ce that in the presence of the other nitrates. It was noticed in cultures that B. pyocyaneus readily produces the pigment in on, but does not do so readily in artificial solutions, and the cases are the only exceptions noted. B. pyocyaneus also formed tle layer on surface, while B. New Jersey failed to produce any or pellicle. After eighteen days the different cultures were with diphenylamine for nitrates and nitrites, with negative s, excepting, of course, 1 and 2, which had been kept sterile, herefore unchanged. The analysis of the insoluble organic

nitrogen formed was carried out as in the other experiments. The total nitrogen in the filtrate was also determined in each case. The results obtained were as follows:

	Insoluble Organic N.	N. in Filtrate.	Total N.
1	......	27.0 mg.	27.0 mg.
2	......	27.0 "	27.0 "
3	1.89 mg.	6.09 "	7.98 "
4	2.04 "	10.29 "	12.33 "
5	2.34 "	4.14 "	6.48 "
6	2.49 "	9.66 "	12.15 "
7	4.59 "	7.07 "	11.66 "
8	3.09 "	10.86 "	13.95 "
9	1.74 "	2.34 "	4.08 "
10	2.94 "	6.66 "	9.60 "
11	1.74 "	2.94 "	4.68 "
12	3.99 "	8.49 "	12.48 "
13	3.66 "	2.94 "	6.60 "
14	4.26 "	9.39 "	13.65 "

The amount of insoluble organic nitrogen produced by B. pyocyaneus was in every case but one greater than that produced by B. New Jersey var. This agrees with the experiments reported above, and again indicates that the losses of nitrogen caused by the growth of B. pyocyaneus are not as great as those caused by the growth of B. New Jersey or of B. New Jersey var. in solutions containing nitrates. And the same conclusions must be drawn again, and namely, that either a greater number of B. pyocyaneus is required to reduce a given quantity of nitrate or that the body substance of B. New Jersey is poorer in nitrogen. Of course, one other conclusion is possible, and namely, that in its metabolism B. pyocyaneus produces a greater quantity of insoluble secondary products rich in nitrogen. The one exception noted above, where B. New Jersey var. produced a greater amount of insoluble organic nitrogen than was produced by B. pyocyaneus, was in the solution where ammonium nitrate was used. In this case not all of the nitrogen was in the form of nitrate, and the conditions were somewhat different. The greatest amount of insoluble organic nitrogen formed by B. pyocyaneus was in the solution containing strontium nitrate, the amount prduced in the solution containing barium nitrate being but slightly less. Excepting sample 7, where ammonium nitrate was employed also, B. New Jersey var. produced the greatest amount of insoluble organic nitrogen in the solution containing strontium nitrate, while barium nitrate

s by no means as favorable. Comparing potassium and sodium rate (equivalent amounts of nitrogen were used in the experiment) find a greater production of insoluble organic nitrogen from the er, both by B. New Jersey var. and B. pyocyaneus, and magnesium rate produced the least amount of insoluble organic nitrogen in the e of both B. New Jersey var. and B. pyocyaneus. Looking at it m another standpoint, it appears that the complete denitrification magnesium nitrate required the activity of fewer organisms than true in the case of any of the other nitrates.

Comparing the amounts of nitrogen found in the filtrate—that is, soluble organic nitrogen and ammonia—we find that also here the es caused by B. pyocyaneus were smaller. The greatest amount nitrogen found here, both in the case of B. New Jersey and B. cyaneus, was in the solution containing ammonium nitrate. This s it should be, since part of the nitrogen was contained in the stance as ammonia, and the latter would not be affected in denitrition proper to such an extent. The least amount of soluble organic ammonia found was in the solution where magnesium nitrate used. In the solution inoculated with B. pyocyaneus there was, ever, a greater amount of nitrogen found than in the solution culated with B. New Jersey var. Without exception the amounts oluble organic and ammonia nitrogen found in the different solus was greater where B. pyocyaneus was used for inoculation than re B. New Jersey var. was used. Comparing potassium and ium nitrate we find that in this case more nitrogen was found in solution where the former was used, that applying to B. New sey var. as well as to B. pyocyaneus. In the solutions containing ium and strontium nitrate, respectively, and inoculated with B. New sey var., the amounts of nitrogen found in the solution at the end of experiments were the same. In the case of B. pyocyaneus, how-, the amount of nitrogen found in the strontium nitrate solution greater. Comparing the total amounts of nitrogen recovered we that in every case B. pyocyaneus caused a slighter loss. On the le, every nitrate tried here could be used by both organisms when other source of nitrogen was at their disposal.

lso, Sewerin[1] observed that potassium and sodium nitrate are reed in an unequal degree. B. pyocyaneus, according to him, reduces eater quantity of KNO_3 than of $NaNO_3$. Salzmann[2] observed that

entr. f. Bact., part II., vol. III. (1897), p. 554.
. c., p. 349.

B. Hartlebi could reduce barium as well as lead nitrate, while B. Stutzeri could reduce barium nitrate to barium nitrite only, and that lead nitrate acted as a poison towards B. Stutzeri. Evidently we have to deal here with variations in the reducing power of the different organisms. In the case of B. Hartlebi, for instance, Salzmann found that this organism could reduce potassium chlorate to potassium chloride and potassium ferriccyanide to potassium ferrocyanide, while B. Stutzeri remained indifferent in this respect. The intensity of the reduction determines the amount of the intermediate products of reduction which appear. Thus the reduction of barium nitrate to barium nitrite by B. Stutzeri merely shows that its reducing power is more limited than that of B. Hartlebi. When the intensity of denitrification is diminished the intermediate products, nitrite and ammonia, appear. This is best illustrated by the behavior of B. coli in solutions containing nitrate. It is well known that B. coli has the power of reducing nitrate to nitrite. An experiment by Wolf proves[1] that B. coli can also reduce nitrates completely, provided that the concentration is slight. In this particular experiment quantities of KNO_3 up to .08 per cent. were reduced with the evolution of nitrogen. B. typhosus reduced quantities of KNO_3 up to .09 per cent., B. Fitzianus up to .18 per cent., a bacillus resembling B. subtilis up to .22 per cent. Sewerin found[2] that out of nine organisms which reduced nitrate to nitrite in a .3 per cent. solution, two produced a complete reduction of the nitrate in a .1 per cent. solution and four more were capable of completely reducing the nitrate in a .05 per cent. solution of KNO_3. It thus appears that, in many cases at least, bacteria differ as to their power of denitrification in degree rather than in kind. At the same time there are bacteria incapable of reducing nitrates, while they can readily destroy nitrites with the evolution of free nitrogen. This is true of B. denitrificans, as proved by Weissenberg,[3] and also of Bacillus 21, isolated in this laboratory. Lemmermann[4] objects to Weissenberg's conclusions and brings forward Künnemann's claim that B. denitrificans is incapable by itself of destroying not only nitrates, but also nitrites. There is no doubt, however, that Bacillus 21 cannot reduce nitrates when alone, and it is also quite certain that it can destroy nitrites with the evolution

[1] Hygien. Rundschau, vol. IX. (1899), quoted by Lemmermann, l. c., p. 36.

[2] Centr. f. Bact., part II., vol. III., p. 506.

[3] Centr. f. Bact., part II., vol. IV. (1898), p. 42.

[4] L. c., p. 39.

of free nitrogen when growing alone. If, as Weissenberg asserts, the reduction of nitrate to nitrite and the reduction of nitrite itself are distinct processes, then we must assume that B. coli and other bacteria possess the power of reducing nitrate to nitrite in an ample degree, and that, to a limited extent, they also possess the power of reducing nitrite with the evolution of free nitrogen. According to him the reduction of nitrite with the evolution of free nitrogen is due to the withdrawing of the oxygen by the bacterial cell, and he claims to prove this by the fact that with an abundant supply of oxygen in the liquid denitrification proper is either stopped entirely or is materially diminished, while the reduction of nitrate to nitrite may take place. However, it was already pointed out elsewhere that cases are known where the reduction of the nitrate is favored, rather than retarded, by thorough aeration. But, if denitrification consists of two distinct processes, the presence of nitrite should be made evident when tested with the proper reagents during the reduction. As a matter of fact there is some conflicting evidence at hand. Sewerin[1] could detect no nitrite reaction during the entire course of denitrification by one of the bacteria isolated by him, and Künnemann[2] could detect no nitrite in the entire course of denitrification by an organism resembling B. denitrificans II. (B. Stutzeri, Lehmann-Neumann).

The Fixation of Nitrogen by Denitrifying Bacteria.

The fact that certain soil bacteria are capable of fixing atmospheric nitrogen has been known for some time. The work of Berthelot, Kruger, Winogradsky, Beijerinck, Caron and others shows that such bacteria do exist.[3] Stoklasa[4] and Vitek have raised the question whether there is not something in common between the fixation of atmospheric nitrogen on the one hand and the destruction of nitrates with the evolution of free nitrogen on the other. They base their belief on the fact that B. ellenbachensis, which they regard as identical with B. megatherium, can fix atmospheric nitrogen under certain conditions, while under different conditions it reduces nitrates. An observation of Hiltner's[5] also tends to lend credence to this view.

[1] Centr. f. Bact., part II., vol. III. (1897), p. 555.
[2] Landw. Vers. Stat., 50 (1898), 82.
[3] See Jacobitz, Centr. f. Bact., part II., vol. VII. (1901), pp. 783, 833, 876.
[4] Centr. f. Bact., part II., vol. VII. (1901), p. 257.
[5] Centr. f. Bact., part II., vol. IX. (1902), p. 73, abstract.

He found that in the soils inoculated with denitrifying bacteria the yields of plant substance were greater than where the soils were kept sterile. This is not a direct proof, of course, that denitrifying bacteria actually add nitrogen to the soil; the increased yield may also be due to the greater amount of the inert soil nitrogen made soluble by the bacteria, and therefore available to the growing plants. Nevertheless, positive evidence does not exist where there may not be conditions in the soil which would favor the fixation of nitrogen by B. pyocyaneus or other denitrifying bacteria occurring in the soil. The recent work of Winogradsky[1] and that of Beijerinck and van Delden[2] are of great interest in giving us a conception, at least, of the extent and the importance of the nitrogen-fixing bacteria living in arable soils. In this laboratory, also, a considerable amount of work has been done in the study of soil bacteria and their relation to the free nitrogen of the atmosphere. The work is, however, still considered incomplete, and its publication will be delayed until next year.

At the same time some work has been done in order to determine the ability of B. pyocyaneus and of other denitrifying bacteria to fix atmospheric nitrogen. These studies, being in line with other work on the physiology of denitrifying bacteria, are therefore reported here. Since, as has been shown, the growth of B. pyocyaneus in solutions containing considerable amounts of combined nitrogen results in the loss of a greater or slighter proportion of it, the solutions intended for the study of the possible nitrogen-fixing power of this organism contained little nitrogen or none at all. There seems to be some analogy here with the fixation of atmospheric nitrogen by legumes, the fixation in this case taking place only when the amount of the soil nitrogen is insufficient for the needs of the plant. Something similar is probably true of the nitrogen-fixing bacteria. It is possible, of course, that some of these will grow in nitrogen-free solutions by preference, and Winogradsky's Clostridium Pasterianum actually does fix considerable quantities of atmospheric nitrogen in nitrogen-free solution. On the other hand, Beijerinck found[3] that the aerobic organisms isolated by him fix greater quantities of atmospheric nitrogen when they have small quantities of combined nitrogen present in the solution at the beginning of the experiment. The work in this labora-

[1] Centr. f. Bact., part II., vol. IX., (1902), p. 43.
[2] Centr. f. Bact., part II., vol. IX. (1902), p. 3.
[3] L. c.

tory also shows that the presence of a little combined nitrogen at the beginning of the experiment favors the fixation of atmospheric nitrogen.

The solutions used in the study of the nitrogen-fixing power of B. pyocyaneus contained traces of nitrogen, added in the form of peptone. The inorganic solution was made up as in the other experiments. For comparison with B. pyocyaneus there were also used B. New Jersey and B. megatherium, the latter having been found to possess some nitrogen-fixing power. As the source of carbon citric, lactic, a tartaric acid was used at the rate of 20 gr. per liter; 100 cc. of solution was employed in each case. The reaction was neutral to faintly alkaline. In each flask there was also added .5 gr. of calcium carbonate. The following was the arrangement of the experiment:

B. NEW JERSEY.

1. Inorganic solution, .1 mg. peptone, 2 gr. citric acid—Sterile.
2. " " " " " " " Inoculated.
3. " " " " " " " "
4. " " " " " lactic " Sterile.
5. " " " " " " " Inoculated.
6. " " " " " " " "
7. " " " " " tartaric acid—Sterile.
8. " " " " " " " Inoculated.
9. " " " " " " " "

B. MEGATHERIUM.

10. Inorganic solution, .1 mg. peptone, 2 gr. citric acid—Inoculated.
11. " " " " " " " "
12. " " " " " lactic " "
13. " " " " " " " "
14. " " " " " tartaric acid "
15. " " " " " " " "

B. PYOCYANEUS.

16. Inorganic solution, .1 mg. peptone, 2 gr. citric acid—Inoculated.
17. " " " " " " " "
18. " " " " " lactic " "
19. " " " " " " " "
20. " " " " " tartaric acid "
21. " " " " " " " "

B. SUBTILIS.

22. Inorganic solution, .1 mg. peptone, 2 gr. citric acid—Inoculated.
23. " " " " " " " "
24. " " " " " lactic " "
25. " " " " " " " "
26. " " " " " tartaric acid "
27. " " " " " " " "

Four days after inoculation 2 and 3 showed distinct turbidity and growth, 16 was coludy, as was 21. The rest were all clear. In seven days 2 and 3 were turbid, 16 and 17 turbid, 18 and 19 cloudy, 20 and 21 turbid. The rest were all clear. In two weeks 2, 3, 16, 17, 18, 19, 20 and 21 were turbid; the others all clear, with no signs of growth.

At the end of three months 2 and 3 were turbid, and 16, 17, 18 and 19 turbid, with membrane on surface. The others appeared clear. The cultures were then sterilized in the autoclave, the solutions filtered and the nitrogen determined, both in the filtrate and in the filtered residue. After substracting the blanks the following amounts were obtained:

NITROGEN FOUND.

	Insol. Organic.	Soluble Organic.	Total.
1	....	....	....
2	Traces.	Traces.	Traces.
3	.15 mg.	.14 mg.	.29 mg.
4 to 15 inclusive	....	....	....
16	.14 "	.35 "	.49 "
17	.14 "	.39 "	.53 "
18	.44 "	.08 "	.52 "
19	.44 "	.24 "	.68 "
20 to 27 inclusive	....	....	....

It will be seen that B. New Jersey produced a slight growth in citric acid, but the nitrogen found was not above the limit of error. No growth was observed, either in the lactic or tartaric acid, and no nitrogen was found. B. megatherium and B. subtilis showed no growth, and no nitrogen was found in the solutions. B. pyocyaneus made considerable growth, showing a gain in the lactic acid of more that .5 mg. of nitrogen. To be sure, the gain was slight, and it may be claimed that it is within the limits of error. Nevertheless, there is no doubt as to the results, for the work was carefully done and the duplicates agreed. Here it appears again that of the three organic acids employed B. New Jersey found the citric acid the most suitable, while B. pyocyaneus found the lactic acid more suitable, although it made some growth, also, in critic acid. In order to prove the fact with certainty, and namely, that B. pyocyaneus can obtain small quantities of nitrogen from the air, the experiment was repeated.

Some modifications were adopted here, however; instead of 100 cc. of solution, 200 cc. were taken, and only citric and lactic acid were

ach at the rate of 5 gr. per liter. The inorganic solution was same composition, and .5 gr. of calcium carbonate were also in each case. The solutions were made faintly alkaline to phytaleine by the addition of sodium hydroxide. Flasks of g sizes were used, so as to expose a greater or smaller surface. 1, 2, 3 and 4 were of 500 cc. capacity and 5, 6, 7 and 8 of cc. capacity, 9 and 10 in large, flat dishes. The quantity of e added was also variable, as shown in the accompanying tabu-

Inorganic	solution,	1	gr.	lactic	acid	.1	mg.	peptone.
"	"	1	"	citric	"	.1	"	"
"	"	1	"	lactic	"	.5	"	"
"	"	1	"	citric	"	.5	"	"
"	"	1	"	lactic	"	.1	"	"
"	"	1	"	citric	"	.1	"	"
"	"	1	"	lactic	"	.5	"	"
"	"	1	"	citric	"	.5	"	"
"	"	1	"	lactic	"	.1	"	"
"	"	1	"	citric	"	.1	"	"
"	"	1	"	lactic	"	.5	"	"
"	"	1	"	citric	"	.5	"	"

except 11 and 12 were inoculated with B. pyocyaneus.
he end of six weeks the following observations were made:

1. Cloudy, some growth.
2. Clear, apparently no growth.
3. Cloudy, somewhat more growth than in 1.
4. Clear, no apparent growth.
5. Cloudy, growth more abundant than in 3.
6. Slight cloudiness.
7. Cloudy, growth as in 5.
8. Slight cloudiness, more pronounced than in 6.
9. Probably growth.
0. " "
1. Clear.
2. "

se observations indicated that lactic acid was a more suitable m than citric acid, for whatever growth was made by B. pyo- is. The extent of surface had an evident influence on the , for, while there was no apparent growth with citric acid in there was some growth in 6 and 8. On analysis, the following s were obtained:

	Insoluble Nitrogen.	Soluble Nitrogen.	Total Nitrogen.		Insoluble Nitrogen.	Soluble Nitrogen.	Total Nitrogen.
1	.15 mg.	....	.15 mg.	7	.60 mg.	....	.60
2......	....	....	....	8......	.15 "	....	.15 "
3	.30 "	....	.30 "	9	.75 "	.80 mg.	1.55 "
4......	....	....	....	10......	.60 "	.75 "	1.35 "
5	.39 "	....	.39 "	11......	....	....	———
6......	....	....	....	12......	....	....	———

The fact is here brought out again and placed beyond the shad of a doubt that B. pyocyaneus were enabled to obtain small quantit of nitrogen not contained in the solution, that this power increas as the surface exposed increased, and that lactic acid served as a better source of carbon than did citric acid. In fact, there was evident growth in the citric acid solution contained in the 500 flasks, but there was some growth in the same solution, as it spread out in a thinner layer in the flat-bottomed, 1,000 cc. flas The quantity of peptone added, though containing an unweighab amount of nitrogen, exerted a considerable influence. With an add tion of .1 mg. the growth was not as extensive as with .5 mg. Thu with .1 gm. of peptone in 1, half as much nitrogen was fixed as 3, where .5 mg. was added to the solution. At the same time, the was even more nitrogen fixed in 8, where only 1 mg. of peptone w added, than there was in 3, where .5 mg. of peptone was added, b where the liquid was shallow and the surface exposed proportionate great, the amount of nitrogen fixed was greater than in 7, where mg. of peptone were added, but where the depth of liquid was great and the surface area exposed much less. Moreover, in 9 and 10 the were not only greater amounts of nitrogen found as insoluble organ but also comparatively considerable quantities in the filtrate as solu organic. This experiment clearly indicates that B. pyocyaneus h the power of fixing small quantities of atmospheric nitrogen; th this fixation is largely influenced by the organic compound used the source of carbon and of energy. Lactic acid is decidedly superi to citric acid, but with thorough aeration, also, the latter can be u for the purpose. Furthermore, the amount of nitrogen fixed is in fluenced by the depth of the liquid layer, and that, everything bei equal, the greater the surface exposed the greater the amount of nitr gen fixed. It is possible that, under still different conditions, not y tried, even a greater fixation may be obtained. Similar experiment with the symbiotic B. 20 and B. 21 have been tried, and also othe

pyocyaneus. In the former case, small quantities were un-
ly fixed, quantities too small to make the results decisive; in
r case the results obtained were similar to those stated above,
l not be given here.
w far this fixation is a factor in our arable soils yet remains
etermined; but from the theoretical standpoint the results
here are of great interest, in that they show how the same
n may at times exert a destructive effect on combined nitro-
l at other times it may actually add to the world's store of
d nitrogen. It is hoped that further experiments will be
n order to shed more light on these physiological processes.

itrogen Content of Some New Jersey Soils and Subsoils.

soils and subsoils were collected in the fall of 1901, and
them are typical South Jersey soils. The subsoils were
ed to agree with the corresponding soils. Samples IX. and
vell as the corresponding subsoils, obtained in the vicinity of
on, were lost in transit and could not be recovered. The
n content reduced to the water-free basis, as well as partial
cal analysis of the different samples, are given here.

SOIL III.

ned from the farm of C. C. Hulsart, Matawan. A rather
ndy loam, underlaid by a yellowish sand, and that, in turn,
It is a well-drained soil, well adapted for early truck.

SOIL IV.

sample was obtained from the farm of John H. Denise, Free-
This is a deep, heavy loam, famed for its great crops of pota-
d situated in the marl area.
l be seen that this subsoil is a fine-grained soil of great water-
power. The sample of soil was taken to a depth of twelve
of the subsoil to a further depth of sixteen to eighteen inches.

SOIL V.

Obtained from the farm of A. P. Arnold, Vineland. This is a very light, sandy soil, underlaid by coarse sand or sandy clay; a warm and well-drained soil, but poor in organic matter, and but five to six inches deep. Excellent crops of sweet potatoes are raised on this soil.

SOIL VI.

Obtained from the farm of G. A. Mitchell, Vineland. This is somewhat heavier than soil V., is deeper and underlaid by a gravelly or clayey subsoil. The crops raised are principally sweet potatoes, early truck and peaches. Sweet potatoes are grown year after year, with the application of commercial fertilizers. It will be noticed that this is much finer that soil V.

SOIL VII.

Obtained from the farm of H. L. Parkhurst, Hammonton. The soil varies from the sandy type, like the Vineland sweet potato soils, to a heavier, sandy loam. The soil is six to eight inches deep and underlaid by yellow sand to gravelly clay. Hardpan occurs in some places at a depth of two feet. The principal crops raised are peaches, pears and small fruit.

SOIL VIII.

Obtained from farm near Egg Harbor City, through the kindness of V. P. Hoffman. This a very light, sandy soil. On higher ground it is inclined to be gravelly. The subsoil is a yellow sand, gravelly in some places and clayey in others, forming hardpan at a depth of about two feet. The hardpan is underlaid by reddish or whitish clay. Gravel beds also occur in the vicinity. The principal crops raised are berries (particularly blackberries), grapes, etc.

SOIL XI.

ned from the farm of J. C. Griscom, Woodbury. The pre-
ype is a sandy to a sandy loam and, in low places, clayey.
soil varies from a grayish to a yellowish sand, to which vary-
ntities of clay are admixed. In low places the subsoil is a
(brick clay). The principal crops raised are tomatoes, pota-
n, sweet potatoes, etc.

SOIL XII.

ned from the farm of M. D. Dickinson, Woodstown. This is
oam to a sandy loam soil, with a tenacious clay subsoil. The
crops raised are tomatoes, potatoes, corn and grass.
be seen that this soil is a fine-grained soil, compact and has
vater-holding power.

SOIL XIII.

ned from the farm of I. Hurff Weatherby, Swedesboro. This
ly soil, with a red, sandy to somewhat clayey subsoil. The
is rolling and considerable variations in the prevailing types
ccur. A belt of red soil passes through the region and is
in that the sweet potatoes raised on these red soils are darker
and can be easily distinguished, according to the statement
cal farmers. The principal crops are sweet potatoes, toma-
n and potatoes. Swedesboro is well known as a shipping
r sweet potatoes.
s an open, warm soil, and the mechanical analysis clearly
at it is permeable and easily tilled.

SOIL XIV.

oil was obtained from the farm of Theodore Brown, Asbury
The soil is not unlike that in the immediate vicinity of
oro. The crops raised are sweet potatoes, tomatoes, egg-
nelons, etc.

SOIL XV.

This soil was obtained from the farm of J. R. Adams, near Clarksboro. This soil is rather heavier than soil XIV., and may be designated a sandy loam, tending to become clayey or gravelly. The red soils already mentioned also crop out here. The crops raised are corn, potatoes, wheat and grass. Truck is also raised extensively; particularly sweet potatoes and tomatoes.

SOIL XVI.

Obtained from the farm of H. D. Culin, Hainesport. This is a light, sandy soil, with a yellowish, sandy subsoil, containing a fair admixture of clay and extending to a depth of two and one-half to three and one-half feet. The subsoil is used for making moulding in the foundry. The sample was taken from a field where, for a number of years, commercial fertilizers have been used exclusively. On this particular field onion sets had been grown. Truck and corn are raised extensively in the region.

SOIL XVII.

Obtained from the farm of Emmor Roberts, Moorestown. The soil is a heavy loam, with a clayey subsoil. The principal crops raised are corn, grass, potatoes, wheat. The soil is fine-grained, deep and fertile.

SOIL XVIII.

Obtained from the farm of the De Hirsch School, Woodbine. This is a comparatively new soil, having been cleared about seven or eight years ago. It is light, sandy in character, with a sandy-clay subsoil. The crops raised are berries and fruit, and also truck and forage crops.

SOIL XX.

Obtained from the farm of the De Hirsch School, Woodbine. This is a forest soil, taken to a depth of four inches.

	NO. III.		NO IV.		NO. V.		NO. VI.		NO. VII.		NO. VIII.		NO. XI.	
	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Particles more than 2 mm. in diameter	1.14	4.85	.50	.20	3.50	8.90	1.45	1.65	2.50	4.80	3.60	2.85	1.05	1.75
Particles between 2 and 1 mm. in diameter	.76	.65	.40	.10	9.60	13.00	2.05	2.05	7.20	6.40	5.45	4.10	.95	.65
Particles between 1 and ½ mm. in diameter	9.45	6.95	4.20	1.65	27.65	26.80	10.30	10.40	16.00	16.50	19.50	19.70	7.70	3.55
Particles less than ½ mm. in diameter	88.65	87.55	94.90	98.05	59.29	51.30	86.20	85.90	74.30	72.30	71.45	73.35	90.30	94.05

	NO. XII.		NO. XIII.		NO. XIV.		NO. XV.		NO. XVI.		NO XVII.		NO. XVIII.		NO. XX.
	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.	Subsoil.	Soil.
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Particles more than 2 mm. in diameter	.85	.75	.75	.45	1.50	3.40	2.30	.25	.20	.05	1.00	1.30	6.95	8.40	5.60
Particles between 2 and 1 mm. in diameter	.40	.10	5.60	5.70	5.40	5.75	1.85	.80	1.80	1.50	1.00	.90	11.40	14.60	10.45
Particles between 1 and ½ mm. in diameter	1.40	.60	33.35	36.50	20.30	18.95	20.10	13.05	6.70	4.35	3.15	2.40	19.80	19.90	23.70
Particles less than ½ mm. in diameter	97.35	98.55	60.30	57.35	72.80	71.90	75.75	85.90	91.30	94 10	94.85	95.40	61.85	57.10	60.25

Hygroscopic Moisture, Volatile Matter and Nitrogen in the Different Soils.

Soil.	Nitrogen.	Hygroscopic Moisture.	Loss on Ignition.	Soil.	Nitrogen.	Hygroscopic Moisture.	Loss on Ignition.
I.	.128 %.	1.57 %.	6.10 %.	XI.	.100 %.	.95 %.	4.10 %.
II.	.112 "	1.29 "	5.46 "	XII.	.146 "	1.73 "	7.20 "
III.	.061 "	.77 "	2.93 "	XIII.	.070 "	.50 "	2.68 "
IV.	.125 "	2.28 "	7.23 "	XIV.	.073 "	.79 "	5.11 "
V.	.038 "	.36 "	2.25 "	XV.	.083 "	.92 "	4.49 "
VI.	.055 "	.59 "	3.30 "	XVI.	.039 "	.69 "	2.47 "
VII.	.065 "	.90 "	4.44 "	XVII.	.080 "	.90 "	4.30 "
VIII.	.055 "	.54 "	3.09 "	XVIII.	.080 "	.82 "	5.06 "
				XIX.	.193 "	2.10 "	9.82 "

Soils I. and II. are from the College Farm and soil XIX. is the surface soil from a field near the Experiment Station building. It will be noticed that the hygroscopic moisture is greatest in the soils which show the greatest loss on ignition. In all of these soils the loss on ignition is largely due to the organic matter, and hence most of the hygroscopic moisture is held in the different soils by the organic matter. Some of the soils, especially V. and XVI., contain very little organic matter and very little nitrogen; nevertheless, good crops of sweet potatoes are raised on them by the use of commercial fertilizers. The heavier soils, and namely, I., II., IV., XII. and XIX., are rich in nitrogen, show a considerable amount of hygroscopic moisture and also a corresponding loss on ignition. Soil XVII., while heavy and productive, is not as rich in nitrogen as the other heavier soils; in fact, it contains no more nitrogen that the light, sandy soil from Woodbine. The corresponding subsoils, as will be seen from the subjoined table, are poorer in organic matter and in nitrogen than the surface soils, which should be expected, since the greater amount of organic matter tends to accumulate at the surface.

Hygroscopic Moisture, Loss on Ignition, and Nitrogen in the Different Subsoils.

Subsoil.	Nitrogen.	Hygroscopic Moisture.	Loss on Ignition.	Subsoil.	Nitrogen.	Hygroscopic Moisture.	Loss on Ignition.
III.	.017 %.	0.36 %.	1.35 %.	XII.	.042 %.	1.10 %.	3.85 %.
IV.	.039 "	1.99 "	4.69 "	XIII.	.020 "	.37 "	1.59 "
V.	.028 "	.49 "	2.61 "	XIV.	.023 "	.72 "	4.06 "
VI.	.018 "	.38 "	1.80 "	XV.	.034 "	1.05 "	3.82 "
VII.	.024 "	.85 "	3.11 "	XVI.	.024 "	1.26 "	3.23 "
VIII.	.011 "	.19 "	1.06 "	XVII.	.037 "	1.41 "	4.98 "
XI.	.043 "	1.03 "	3.34 "	XVIII.	.034 "	.58 "	2.98 "

differences between the nitrogen content of the soils and sub- are very decided. Thus, subsoil IV., representing the second inches, has a nitrogen content of only .039 per cent., while rresponding soil, representing the upper twelve inches, has a en content of .125 per cent. Similarly, the hygroscopic moist- subsoil IV. is 1.99 per cent., as against 2.28 per cent. in the twelve inches, and the loss on ignition from the subsoil is 4.69 nt., as against a loss of 7.23 per cent. from the upper twelve . In the lighter, nitrogen-poor soils the differences are not as In subsoil V., representing the second eight inches, the nitro- ntent is .028 per cent., as against .038 per cent. in the upper inches, while the hygroscopic moisture and the loss on ignition en greater in the subsoil than they are in the upper soil. A rison of the tables will bring out similar relations in the other nd subsoils.

REPORT OF THE ASSISTANT IN HORTICULTURE.

REPORT OF THE ASSISTANT IN HORTICULTURE.

he year past has been fully occupied with the detail of the various ıanent experiments outlined in previous reports of this depart- t. Any changes or additions made are noted in their respective es.

he usual records of the weather conditions have been made ughout the year, and show the season, particularly the growing on, to have been an exceptional one as regards temperature and fall. The early months were comparatively warm months. The thly mean for March was 4.7 degrees above the average mean the period covered by our records. The mean temperature for ch, April and May averaged 2.2 degrees above the general averages the same months in preceding years. Accompanying these tem- tures was a deficiency of rainfall amounting to a little over an ı per month. The next four months are to be noticed for their mean temperatures and high rainfall. The mean temperature June was 1.9 degrees and for August 4 degrees below the normal, ı the average for the four months 3 degrees below the normal. rainfall for this period averaged .86 inch per month above the mal. Including October the excess above the normal rainfall als 1.55 inches per month. The total rainfall for the year equals 36 inches, which is 8.49 inches above the normal for this section. 'able 1 contains in detail the records of the rainfall at this Station the past year, while Table 2 contains the monthly and yearly rds since January 1st, 1892. The monthly and yearly normal is included.

TABLE 1.

Showing Daily and Monthly Precipitation in Inches at the College Farm for the Year Ending October 31st, 1902.

DATE.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.
1	T	....	....	0.10	0.08	0.08	....	....	0.34	....	....	2.47
2	....	....	....	0.50	0.69	....	....	....	....	0.21	0.04	....
3	....	1.32	0.05	....	0.08	....	0.37	....	0.28	2.11	....	....
4	....	0.06	....	....	....	....	....	....	....	0.08	0.02	[illegible]
5	....	....	....	....	0.66	....	....	....	0.08	....	....	[illegible]
6	....	....	....	....	....	0.09	....	....	0.06	0.82	....	[illegible]
7	....	....	....	....	....	0.35	....	0.10	....	....	0.09	....
8	....	....	0.14	....	0.07	1.18	....	....	....	....	....	....
9	....	....	0.10	....	0.79	0.33	....	....	....	....	0.63	....
10	....	0.37	....	....	....	0.08	....	....	T	0.29	0.25	....
11	0.14	....	0.02	....	....	T	....	0.08	....	1.21	....	[illegible]
12	0.21	....	....	....	....	0.01	....	0.17	....	....	....	[illegible]
13	....	0.02	....	T	0.03	T	0.04	....	....	....	0.29	....
14	T	0.01	....	....	....	....	....	0.72	....	....	0.11	....
15	....	1.05	....	....	....	....	....	....	0.14	....	....	....
16	....	....	....	....	T	....	....	....	0.07	0.09	....	....
17	....	....	....	1.25	0.35	....	....	0.70	0.13	....	....	[illegible]
18	....	T	....	....	....	....	....	....	T	....	0.06	....
19	....	....	....	....	T	....	T	0.20	0.04	....	T	....
20	....	....	....	....	0.02	....	0.12	....	0.01	T	0.33	....
21	....	....	0.06	0.99	....	....	....	1.74	0.16	0.13	0.16	....
22	....	....	1.44	1.40	....	....	....	....	0.08	0.80	0.11	....
23	....	T	....	0.04	....	....	....	....	....	....	....	....
24	1.72	0.23	....	....	....	....	....	....	0.40	....	....	....
25	0.06	0.08	....	0.18	....	....	0.04	0.24	1.10	....	0.81	....
26	....	0.06	0.10	0.80	....	T	0.15	0.70	....	....	0.78	....
27	....	0.97	0.35	....	....	0.02	0.79	....	0.05	0.59	0.45	....
28	....	....	....	1.16	0.11	....	....	....	....	....	0.89	1.82
29	0.08	2.22	0.18	....	0.37	0.36	....	1.43	....	....	0.26	....
30	....	0.96	0.21	....	T	0.59	....	....	0.58	....	....	....
31	....	....	0.10	....	0.04	....	....	....	T	....	....	....
Total 1902	2.21	7.30	2.70	6.46	3.79	3.09	1.51	6.06	3.42	6.29	5.25	7.76
Normal rainfall	3.74	3.66	3.82	3.64	3.77	3.68	4.02	3.80	4.92	4.98	3.94	3.45

TABLE 2.

Showing Monthly Precipitation in Inches Since January 1st, 1896.

	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Yearly total.
Total, 1896..	....	....	1.68	5.85	5.92	1.41	3.70	4.93	4.37	2.42	4.81	1.62	*36.71
Total, 1897..	2.95	1.59	2.39	2.77	2.47	3.47	6.45	2.50	12.84	3.81	2.10	1.59	44.93
Total, 1898..	4.52	5.09	3.92	3.49	3.09	4.17	7.86	1.18	3.91	6.44	1.46	5.80	50.88
Total, 1899..	7.14	3.16	4.88	5.87	6.63	1.50	2.04	3.54	6.82	3.45	7.80	2.96	54.79
Total, 1900..	4.11	2 06	4.35	5.30	3.40	2.38	5.58	2.64	6.94	2.24	3.30	3.53	45.83
Total, 1901..	4.27	2.32	2.01	0.76	5.19	7.39	5.01	0.81	9.12	8.90	1.86	1.99	49.63
Total, 1902..	2.21	7.30	2.70	6.46	3.79	3.09	1.51	6.08	3.42	6.29	5.25	7.76	55.86
Normal	3.74	3.66	3.82	3.64	3.77	3.68	4.02	3.80	4.92	4.93	3.94	3 45	47.37

*Ten months only.

The Permanent Experiment Plots.

ASPARAGUS AND THE SMALL FRUITS.

The general plan is as follows: In each case, currants and gooseberries excepted, six varieties, or six rows 160 feet long and set in one block, are duplicated, giving twelve rows, of which rows 1 and 7, 2 and 8, etc., are of the same variety. Rows 7 to 12, inclusive, are irrigated as occasion demands, nothing being applied upon rows 1 to 6. Lengthwise, each plot is divided into four equal plots, forty feet long. Those unirrigated are numbers 1 to 4, those irrigated 5 to 8. Plots 1 and 5, 2 and 6, etc., are treated identically, except that plots 5 to 8 are irrigated. The plan for currants and gooseberries is the same, excepting that there are four varieties instead of six, with six plots, twenty-five feet long, instead of eight plots.

Table 3 shows in detail the fertilizers or manures to be applied to the various plots, with the times for application; all of which has been carefully followed the past season. Water was applied to the irrigated plots the last of May and the first of June, as noted in each case.

TABLE 3.

Showing Fertilizers, Amounts and Time Applied to the Different Plots, Asparagus and Small Fruits.

KIND OF FRUIT OR VEGETABLE.	Plots 1 and 5.	Plots 2 and 6.	Plots 3 and 7.	Plots 4 and 8.
Asparagus	20 ts. * yard manure applied in fall.	500 lbs. complete † applied in spring.	500 lbs. complete applied in spring; 300 lbs. bone and potash‡ applied in fall.	500 lbs complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs nitrate soda applied when cutting ended.
Blackberries..	20 ts. yard manure applied in fall.	500 lbs. complete applied in spring.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall.	500 lbs. complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs. nitrate soda applied after blossoming.
Raspberries....	20 ts yard manure applied in fall.	500 lbs. complete applied in spring.	500 lbs complete applied in spring; 300 lbs. bone and potash applied in fall.	500 lbs complete applied in spring; 300 lbs. bone and potash applied in fall; 200 lbs nitrate soda applied after blossoming.
Strawberries...	500 lbs. complete applied in spring.	500 lbs. complete applied in spring; 150 lbs. nitrate soda applied after blossoming.	500 lbs. B., P. and A. P.§ applied in spring; 150 lbs nitrate soda applied after blossoming.	500 lbs. B., P. and A. P. applied in spring.
	Plots 1 and 4.	Plots 2 and 5.	Plots 3 and 6.	
Currants	20 ts. yard manure applied in fall.	500 lbs. B., P. and A. P. applied in fall.	500 lbs. B., P. and A. P. applied in fall; 150 lbs. nitrate soda applied after blossoming.	
Gooseberries...	20 ts. yard manure applied in fall.	500 lbs. B., P. and A. P. applied in fall.	500 lbs. B., P. and A. P. applied in fall; 150 lbs. nitrate soda applied after blossoming.	

* The quantities of manure or fertilizer given are in every case the amounts per acre to be applied.

† Complete Fertilizer—a mixture of the best forms of fertilizing constituents, analyzing nitrogen, 4.5 per cent.; phosphoric acid (available), 7.7 per cent., and potash, 12.3 per cent.

‡ An even mixture of ground bone and muriate of potash.

§ An even mixture of ground bone, muriate of potash and acid phosphate.

general arrangement of plots, fertilizers, etc., allows a study

a. The effect of irrigation.
b. The relative effect of fertilizers and manures with and without irrigation—
  1. Upon the early yield.
  2. Upon the total yield.
c. The effect of the addition of nitrate of soda.

ASPARAGUS.

plantation was thoroughly worked the 2d of April, crowns und the 12th and ridged preparatory to cutting April 21st. The utting of "grass" was taken April 23d, eight days earlier than)1. Asparagus was selling in this market upon that date at ıts per pound bunch. The last cutting was taken June 20th, g the thirtieth for the season. Asparagus was then selling at ts per bunch.

ıures and fertilizers were applied as follows: December 6th, ıanure to plots 1 and 5, and bone and potash to plots 3, 4, 7 April 21st, plots 2, 3, 4, 6, 7 and 8 received the complete fer- and plots 4 and 8 the nitrate on July 12th. Water was ap- o the irrigated plots 5 to 8 but once this season, giving three- s inch of water May 31st.

records of the year are given in Table 4, together with the an- otals for the four previous crops, and the average per year of e crops cut from the plantation.

sidering varieties in early yield, Palmetto has not made the ıg this season that it has in the past. Of the eight plots, Pal- leads in early yield on three, Barr's Mammoth on three and ı on two plots. The seconds in early yield are Colossal on plots, Columbian on two, and Barr's Mammoth, Elmira and tto one each.

n past seasons, Palmetto leads in the total yield upon all plots plot 5, where it stands fourth in order. It is peculiar that tto, upon plot 5, should fail to respond as it does upon all the plots, and for three years in succession. The variety second ıl yield is apt to vary from year to year; however, looking at

TABLE 4.

Asparagus—Fertilizer Plots.

VARIETY.	UNIRRIGATED. Plot 1. First three cuttings.	Plot 1. Total cut.	Plot 1. Tops.	Plot 2. First three cuttings.	Plot 2. Total cut.	Plot 2. Tops.	Plot 3. First three cuttings.	Plot 3. Total cut.	Plot 3. Tops.	Plot 4. First three cuttings.	Plot 4. Total cut.	Plot 4. Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.
Barr's Mammoth...	38.5	390.0	17.25	26.0	380.0	12.25	8.0	218.0	9.00	8.0	274.0	[illegible]
Donald's Elmira.....	30.5	502.0	25.25	21.5	390.5	13.00	18.0	412.5	15.50	15.0	372.0	[illegible]
Columbian Mammoth White.......	30.0	447.5	22.25	25.5	430.0	14.00	8.0	292.0	9.25	8.0	322.0	[illegible]
Palmetto	30.5	651.5	29.50	24.5	519.0	26.00	11.5	466.0	20.25	19.0	457.0	[illegible]
Conover's Colossal.	34.0	494.5	19.25	18.0	361.5	11.50	15.0	315.5	10.25	12.5	[illegible]	[illegible]
Giant Brunswick...	16.5	396.0	18.00	10.5	326.0	11.50	9.5	250.0	6.50	8.0	[illegible]	[illegible]
Total	180.0	2881.5	131.50	126.0	2407.0	88.25	70.0	1958.0	70.75	70.5	1961.0	[illegible]
Totals for 1898..	68.0	238.5	156.00	95.5	234.5	113.50	76.5	176.5	108.00	67.0	158.0	[illegible]
Totals for 1899..	136.0	697.0	109.50	148.0	620.0	76.50	130.0	537.5	76.00	98.0	[illegible]	[illegible]
Totals for 1900..	149.5	1786.5	176.00	229.0	1540.5	118.00	182.0	1389.0	102.90	149.0	1224.0	[illegible]
Totals for 1901..	63.5	2089.0	242.25	133.0	1645.5	198.75	90.0	1426.5	155.25	71.0	[illegible]	[illegible]
Average per year, five crops	119.4	1528.5	163.05	146.3	1289.5	119.00	109.7	1096.5	102.46	91.1	[illegible]	[illegible]

Asparagus—Fertilizer Plots.

VARIETY.	IRRIGATED. Plot 5. First three cuttings.	Plot 5. Total cut.	Plot 5. Tops.	Plot 6. First three cuttings.	Plot 6. Total cut.	Plot 6. Tops.	Plot 7. First three cuttings.	Plot 7. Total cut.	Plot 7. Tops.	Plot 8. First three cuttings.	Plot 8. Total cut.	Plot 8. Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.
Barr's Mammoth	14.0	414.0	30.00	13.5	293.5	10.50	18.0	267.5	10.50	22.0	276.0	[illegible]
Donald's Elmira....	31.0	457.0	22.50	12.0	481.5	19.50	9.5	284.0	13.50	8.0	[illegible]	[illegible]
Columbian Mammoth White........	27.5	489.0	19.75	23.5	391.5	15.50	6.5	340.5	13.25	15.5	[illegible]	[illegible]
Palmetto	16.0	419.5	27.75	32.5	586.0	23.50	33.0	528.0	21.50	18.0	[illegible]	[illegible]
Conover's Colossal..	20.0	434.5	20.00	29.5	483.5	17.25	15.0	390.0	16.50	8.5	314.0	[illegible]
Giant Brunswick...	5.5	256.0	11.00	....	278.0	6.00	4.5	283.5	13.00	5.5	[illegible]	[illegible]
Total.	114.0	2470.0	131.00	111.0	2462.0	92.25	86.5	2083.5	88.25	77.5	[illegible]	[illegible]
Totals for 1898..	72.5	224.5	187.50	100.0	288.5	111.50	84.5	196.5	108.50	77.5	[illegible]	[illegible]
Totals for 1899..	135.0	666.0	116.50	180.0	658.5	87.00	136.5	589.5	77.00	[illegible]	[illegible]	[illegible]
Totals for 1900..	109.5	1590.5	176.50	206.5	1544.5	186.50	200.0	1447.0	117.00	151.5	[illegible]	[illegible]
Totals for 1901..	56.5	1770.5	282.50	83.0	1806.5	188.50	75.5	1488.5	158.25	58.5	[illegible]	[illegible]
Average per year, five crops	97.5	1334.3	158.80	136.1	1342.0	122.15	116.6	1151.0	108.80	[illegible]	[illegible]	[illegible]

sults upon the different plots for the four past seasons, Elmira second and Columbian Mammoth White third in order.

further compare varieties, the yields of the different sorts dure five years of cutting from the field are combined and averaged he results calculated to the basis of one acre. The following ns the figures, as above, with similar figures for the crop of

	1902.		Average, Five Crops.	
	Early Yield.	Total Yield.	Early Yield.	Total Yield.
	lbs.	lbs.	lbs.	lbs.
r's Mammoth	251.8	4,282.8	255.4	2,396.8
ald's Elmira	247.6	5,450.1	295.2	3,068.8
umbian Mammoth White	245.9	5,017.1	284.0	2,684.9
metto	314.8	6,984.9	385.4	4,013.8
over's Colossal	259.5	5,132.8	236.0	2,817.4
nt Brunswick	102.1	3,864.3	92.4	1,660.0
ore's Cross-Bred	165.1	4,708.4	160.6	2,355.4
nt Argenteuil	*177.0	*1,626.7	†140.6	†1,049.8

1902 Elmira is second, Colossal third and Columbian Mam-White fourth in yields. Taking the averages of the five crops, tto exceeds by 945 pounds any other sort. Elmira is second, he Colossal third in total yields.

wholesale price of asparagus in our market this year averaged, early cut, 16 cents per pound, and for the total, 10.46 cents. ng 10 per cent. for waste, etc., in bunching, the market value early and total yields of Palmetto are $45.33 and $657.56 per xceeding all others by $7.47 and $144.49, respectively, for the nd total yield.

he combined averages, Palmetto exceeds all others by 63.2 and 945 pounds, worth commercially $9.10 and $88.96 per espectively, for the early cut and the total yield.

idering the results upon the different plots, the varieties taken r, we have:

In early yield, two of the irrigated plots exceed, and two are ed by, the unirrigated duplicates. The same is true of the total *i. e.*, two exceeding and two exceeded by the unirrigated dupli- Taking the four plots in each case together, those unirrigated those irrigated by nearly 15 per cent. in early, and 4 per cent. l, yields. In the top growth the irrigated plots exceed in three nd are practically identical in the fourth plot (1 vs. 5).

d year's cut.
rst years' cutting only.

Considering the annual average of the five crops, plots 1 and 2, unirrigated, and 7 and 8, irrigated, exceed their duplicates in early yield. Taken together, the unirrigated plots exceed those irrigated by a little over 5 per cent.

In total yields and in growth of tops, three of the irrigated plots, *i.e.*, 6, 7 and 8, exceed the unirrigated duplicates. Taken together, however, the unirrigated plots exceed in total yield those irrigated by a little over 1 per cent. In top growth the irrigated plots exceed by 4 per cent. those unirrigated.

(*b*) In early yield, plots 1 and 5 (yard manure) have given the largest cut, with 2 and 6 second. With the totals, plot 1 (manure), unirrigated, and 6 (complete fertilizer), irrigated, lead, with 2 and 5 second. In top growth, 1 and 5 excel, with 2 and 6 second.

Averaging the five crops, the early yield of plots 2 and 6 (complete fertilizer) exceed by 22.5 and 16.7 per cent., respectively, the next plots in yield. In the total yield, plot 1 (manure) exceeds the next in yield, where unirrigated, by 18.5 per cent., and, when irrigated, plots 6 and 5 are practically identical—7.7 pounds per acre in favor of plot 6.

The annual top growth averages much larger upon plots 1 and 5 (manure) than upon the other plots.

(*c*) Nitrate of soda added to plot 4, unirrigated, has given an early yield practically identical with plot 3, and exceeding it somewhat in total yield and top growth, but, where irrigated, plot 8 has given the lowest yields throughout.

Considering where the five crops are averaged the plots receiving nitrate (4 and 8) are the lowest in yield in every case.

Table 5 contains the detailed record for the year of the two new sorts and the two rows set with selected crowns. The yearly totals are also included, as well as the annual yield for the five crops harvested.

With slight variations in early yields, the results upon the different plots are identical with those upon the unirrigated plots already discussed.

It was stated in the last report that "the advantage derived from setting the large selected crowns has entirely disappeared." The same holds true the present year. In all cases the yields obtained upon the permanent plots exceeds that from plots treated identically, but which were originally set with selected crowns.

TABLE 5.

Asparagus—New Varieties and Selected Crowns.

ETY.	PLOT 1.			PLOT 2.			PLOT 3.			PLOT 4.		
	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.	First three cuttings.	Total cut.	Tops.
	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.	oz.	oz.	lbs.
Elmira....	13.5	434.5	21.00	20.0	438.0	19.25	2.5	362.5	11.25	6.0	262.0	8.75
....	24.0	543.0	31.00	20.0	432.5	21.00	14.0	449.0	23.00	8.5	445.5	20.50
oss-Bred.	12.5	362.0	13.25	7.0	327.0	10.50	20.0	351.0	12.50	9.0	343.5	10.00
enteuil...	2.5	108.0	14.50	13.0	117.0	14.25	20.0	115.0	18.25	16.5	138.0	26.75
....	52.5	1447.5	79.75	60.0	1314.5	65.00	56.5	1277.5	65.00	40.0	1189.0	66.00
for 1898..	64.5	152.0	95.00	40.0	117.5	61.50	57.5	140.5	86.00	49.0	119.0	68.50
for 1899..	97.0	425.5	59.00	77.5	357.5	49.50	64.0	341.5	47.50	43.5	277.5	45.00
for 1900..	102.0	956.0	95.50	78.5	805.5	94.00	81.5	782.5	98.00	71.5	579.0	72.00
for 1901..	27.5	920.0	120.75	58.5	865.0	121.75	58.0	820.0	120.00	28.0	804.0	130.00
er year, s............	68.7	780.2	90.00	61.9	692.0	78.35	63.5	662.4	82.80	46.4	593.7	76.30

BLACKBERRIES.

plantation was trimmed the 1st of March and the space be- rows thoroughly cultivated April 30th. Manure was applied s 1 and 5 December 6th, and bone and potash applied at the me upon plots 3, 4, 7 and 8. May 8th the complete fertilizer read upon plots 2, 3, 4, 6, 7 and 8, as per scheme. June 2d of soda was applied to plots 4 and 8. The irrigated plots l one application of water the past season—*i. e.,* May 31st— water equivalent to one inch of rainfall. Table 6 contains ailed record for the year, together with the annual totals for ir previous crops and the average annual yield for the five arvested from the plantation.

ry small crop of fruit was harvested this season, the smallest, , taken since the patch commenced to fruit. Eldorado has far the most productive the past season, giving 66.4 per cent. ruit than any other sort, but yielding only about one-fourth p of 1900.

TABLE 6.

Blackberries—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED. PLOT 1. Yield first three pickings.	PLOT 1. Total yield.	PLOT 2. Yield first three pickings.	PLOT 2. Total yield.	PLOT 3. Yield first three pickings.	PLOT 3. Total yield.	PLOT 4. Yield first three pickings.	PLOT 4. Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Early Harvest	July 5.	52.5	81.0	28.0	56.0	45.5	94.0	35.0	[illegible]
Wilson, Jr.	" 14.	47.5	95.0	68.0	192.0	54.0	207.0	65.0	[illegible]
Erie	" 14.	13.0	68.0	3.0	60.0	2.5	102.0	15.5	[illegible]
Agawam	" 18.	9.0	30.0	0.5	10.0	2.0	16.0	44.0	[illegible]
Taylor	" 22.	21.5	51.0	10.5	72.0	12.5	40.0	22.5	[illegible]
Eldorado	" 11.	8.0	89.0	16.5	196.0	19.0	185.0	37.5	[illegible]
Total		151.5	414.0	126.5	586.0	135.5	644.0	219.5	[illegible]
Equivalent in quarts		6.3	17.3	5.3	24.4	5.6	26.8	9.1	[illegible]
Totals for 1898, quarts		13.3	87.4	16.4	71.5	24.4	87.2	14.8	[illegible]
Totals for 1899, quarts		8.9	39.6	10.7	61.8	16.2	101.1	15.0	[illegible]
Totals for 1900, quarts		35.7	212.8	32.2	209.6	29.4	196.8	32.5	[illegible]
Totals for 1901, quarts		11.3	47.0	10.7	66.5	7.8	48.5	8.2	51.1
Average per year, five crops		15.1	80.8	15.1	86.7	16.7	92.1	16.0	[illegible]

Blackberries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED. PLOT 5. Yield first three pickings.	PLOT 5. Total yield.	PLOT 6. Yield first three pickings.	PLOT 6. Total yield.	PLOT 7. Yield first three pickings.	PLOT 7. Total yield.	PLOT 8. Yield first three pickings.	PLOT 8. Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Early Harvest	July 5.	39.5	60.0	55.0	86.0	44.0	62.0	62.0	[illegible]
Wilson, Jr.	" 14.	26.0	73.0	30.5	68.0	2.5	22.0	18.0	[illegible]
Erie	" 14.	15.5	140.0	6.0	148.0	1.0	67.0	1.5	[illegible]
Agawam	" 18.	29.5	117.0	10.5	53.0	19.5	73.0	24.0	[illegible]
Taylor	" 22.	45.0	108.0	36.5	90.0	17.0	63.0	44.5	[illegible]
Eldorado	" 11.	12.0	142.0	10.5	168.0	17.0	254.0	31.5	[illegible]
Total		167.5	640.0	149.0	613.0	101.0	541.0	181.5	[illegible]
Equivalent in quarts		7.0	26.7	6.2	25.5	4.2	22.5	7.6	[illegible]
Totals for 1898, quarts		27.2	161.1	29.5	103.1	20.8	67.6	20.0	[illegible]
Totals for 1899, quarts		18.3	98.7	17.0	148.9	18.0	131.7	16.0	[illegible]
Totals for 1900, quarts		41.2	207.0	34.7	195.9	33.8	146.4	29.1	[illegible]
Totals for 1901, quarts		15.2	73.4	12.4	70.0	8.2	43.7	9.7	[illegible]
Average per year, five crops		21.8	113.4	20.0	108.7	17.0	82.4	16.5	[illegible]

bining the yields of the different varieties upon all plots for ır crops, and calculating the yields on the basis of an acre, we he following average annual early and total yields from the ieties grown:

	Early Yield.		Total Yield.	
arly Harvest	993.8	quarts.	2,193.3	quarts.
Vilson, Jr.	553.6	"	1,900.8	"
rie	190.4	"	2,512.0	"
gawam	392.5	"	2,436.9	"
aylor	174.2	"	2,007.8	"
ldorado	411.3	"	2,740.3	"

rado is thus shown to be the most productive sort, averaging ent. yearly more than the next variety, in order of yield—*i. e.*, ie. Wilson, Jr., is the lowest in yield.

idering the yields of 1902 by plots, we have—

Plots 5 and 6, irrigated, exceed their unirrigated duplicates early and total yields. In the other two cases the unirrigated ave the larger yield; combining the four plots in each case the ated plots have the larger early yield, but are exceeded by a ver 3 per cent. in total yields where irrigated.

he average annual yield from the patch the irrigated plots in all cases in early yield. Combined, the increase equals 19.7 it. In total yields, however, only two of the irrigated plots 6) exceed their unirrigated duplicates. Combining the yields case the irrigated plots exceed those not irrigated by 12.7 t.

The relations between the plots are this year considerably dif- than in previous years. Where irrigated the results are the oth in early and total yield—*i. e.*, in order, plots 8, 5, 6 and 7. not irrigated plot 4 also excels in both early and total yield, ot 1 second in early and plot 3 second in total yields.

results of the five crops harvested are the same in the early al yields where irrigated—*i. e.*, in order, plots 5, 6, 7 and 8. unirrigated plot 3 leads in both cases, with plot 4 second in nd plot 2 second in the total yields.

Those plots receiving the extra nitrogen (4 and 8) exceed in nd total yield in 1902. Note particularly the large yields upon lots. The excess over the next plots, in order, equals 25.7 per early and 35.7 per cent. in the total yields.

ne average crop, however, the nitrate plots (4 and 8), where ted, have given the lowest yields, and where not irrigated g second in early and third in total yields.

RASPBERRIES.

The raspberry patch has been cared for along with the blackberries, so that the same dates apply in either case. Plots 5 to 8 received two applications of water (May 30th and July 13th), giving an inch of water each time. Table 7 contains the year's records, together with previous records, as in other cases.

A comparison of varieties by yields is unnecessary, since they do not compare, Cuthbert being by far the better sort. Marlboro is earlier, wherein its value lies. Turner is an abundant yielder, but the character of the fruit is such that it is undesirable, either for home or market.

By plots we have—

(*a*) Irrigation has increased the early yield in all cases and, in all but plot 6, total yield, where the unirrigated plot has slightly the larger yield. The combined figures give an increase of 14.3 per cent. and 8.2 per cent., respectively, for early and total.

In the average crop harvested the early yield is the larger where irrigitated, excelling by 15.3 per cent. The greatest increase occurs upon plot 5. In total yields two plots are exceeded by the unirrigated duplicates, but combined irrigation gives an increase of 5.4 per cent.

(*b*) With one exception, the results of the different plots are the same throughout—*i.e.*, in order of numbering, plots 1 and 5, 2 and 7, 3 and 6, 4 and 8. The exception occurs in plot 7, which exceeds in yield plot 6.

Averaging the five crops harvested the different plots stand as numbered in early yield. In total yields plots 3 and 5 are first, with plots 2 and 7 second in order.

(*c*) Plots 4 and 8, to which nitrate of soda was added, have given the lowest yields throughout early and total yields, both in 1902 and in the average annual crop.

TABLE 7.

Raspberries—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED. PLOT 1. Yield first three pickings.	PLOT 1. Total yield.	PLOT 2. Yield first three pickings.	PLOT 2. Total yield.	PLOT 3. Yield first three pickings.	PLOT 3. Total yield.	PLOT 4. Yield first three pickings.	PLOT 4. Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
t.	June 30.	91.5	411.0	43.5	303.0	44.0	286.0	36.0	229.0
o	" 27.	33.5	157.0	33.0	206.0	49.0	291.0	31.5	178.0
	" 27.	40.5	284.0	43.5	351.0	43.0	349.0	56.0	463.0
	" 27.	21.0	62.0	22.5	47.0	16.5	40.0	14.5	67.0
n	" 24.	136.0	258.0	118.5	246.0	83.5	179.0	43.0	88.0
		322.5	1,172.0	256.0	1,153.0	286.0	1,145.0	181.0	1,025.0
ent in quarts		14.7	58.8	11.6	52.4	10.7	52.0	8.2	46.6
s for 1898,* quarts		7.0	23.7	2.4	11.7	2.4	11.4	2.6	10.3
s for 1899,* quarts		12.4	33.4	6.1	37.2	6.0	33.3	3.0	24.2
s for 1900,* quarts		2.9	33.6	7.7	46.8	5.8	49.5	3.2	36.8
s for 1901, quarts		6.0	31.7	12.1	44.3	12.2	43.7	13.2	42.2
age per year, five ps		8.6	36.1	8.0	38.5	7.4	39.0	6.0	32.0

Raspberries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED. PLOT 5. Yield first three pickings.	PLOT 5. Total yield.	PLOT 6. Yield first three pickings.	PLOT 6. Total yield.	PLOT 7. Yield first three pickings.	PLOT 7. Total yield.	PLOT 8. Yield first three pickings.	PLOT 8. Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
t	June 30.	58.0	370.0	47.5	267.0	36.0	253.0	44.5	228.0
o	" 27.	62.0	378.0	29.5	194.0	46.5	293.0	26.5	230.0
	" 27.	56.0	363.0	64.5	427.0	37.5	366.0	37.5	400.0
	" 27.	32.5	71.0	7.0	14.0	17.5	44.0	10.5	22.0
n	" 24.	142.5	265.0	141.0	239.0	142.0	254.0	98.5	191.0
		351.0	1,442.0	289.5	1,141.0	279.5	1,210.0	217.5	1,071.0
ent in quarts		16.0	65.5	13.2	51.9	12.7	55.0	9.9	48.7
s for 1898,* quarts		8.7	41.5	2.9	14.0	2.8	13.6	2.2	11.2
s for 1899,* quarts		12.0	40.6	7.3	39.3	6.0	41.5	6.0	32.2
s for 1900,* quarts		4.5	37.5	5.5	40.5	4.8	47.4	3.9	39.5
s for 1901, quarts		9.2	39.0	11.4	39.0	13.5	45.9	9.8	38.7
age per year, five ps		10.1	44.8	8.1	36.9	8.0	40.7	6.4	31.1

e varieties only.

CURRANTS AND GOOSEBERRIES.

Plots 1 and 5 received manure and the other four plots the mixture of bone, potash and acid phosphate, the 6th of December. May 6th, nitrate of soda was given plots 3 and 6. Bushes were trimmed the last of March, and the ground thoroughly cultivated April 30th. Plots 4, 5 and 6 received water twice—May 26th and June 13th—applying an inch each time. Table 8 contains full records as in previous cases.

Currants.—Of the four sorts grown, Fay's Prolific finds readier sale, because of its larger size. It is not, however, nearly as productive as the other red sorts. The average annual yield per acre of the four sorts for the past four years are—

Fay's Prolific......	**3,106.3 quarts.**	**Victoria............**	**6,720.8 quarts.**
Red Dutch	**7,150.9 "**	**White Grape.......**	**3,423.1 "**

In keeping the record of yields of the currants, the weights of the product of each bush is made separately. In connection with the low annual yield of Fay's Prolific, it is important and instructive to note some of these individual bushes. There are six plots of seven each, and in each plot wide variations in yield exist between different bushes, and such differences are in evidence year after year.

In the following table is given the record of a few of these bushes, the figures being the total yield to date—six crops—during the fruiting life of the bush. The good and poor are from the same plot and are set opposite each other:

Good.		Poor.	
Plot 1, Bush 3............	191.5	Plot 1, Bush 7............	148.0
" 2, " 3	276.0	" 2, " 7............	200.5
" 2, " 6............	290.0		
" 3, " 2............	271.0	" 3, " 4............	19.5
" 3, " 5............	246.5	" 3, " 7............	22.0
" 4, " 3............	302.0	" 4, " 5............	156.0
" 4, " 4............	334.0	" 4, " 7............	40.0
" 5, " 2............	253.5	" 5, " 5............	35.0
		" 5, " 7............	16.5
" 6, " 7............	330.0	" 6, " 3............	72.5
		" 6, " 5............	51.0
Average............	277.17	Average............	76.10

TABLE 8.

Currants—Fertilizer Plots.

VARIETY.	UNIRRIGATED.			IRRIGATED.		
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.	Plot 6.
	oz	oz.	oz.	oz.	oz.	oz.
Prolific	412.0	598.0	259.0	528.0	233.0	406.0
Dutch	986.0	[illegible]	995.0	889.0	923.0	1,028.0
ria	858.0	649.0	805.0	945.0	726.0	977.0
e Grape	578.0	473.0	652.0	557.0	[illegible]	[illegible]
otal	2,798.0	2,879.0	2,711.0	2,864.0	2,275.0	3,004.0
valent in quarts	139.9	119.0	135.6	143.2	113.8	150.2
otals for 1898, quarts	13.3	3.4	8.8	17.8	11.3	9.4
otals for 1899, quarts	41.2	37.5	49.8	51.8	51.6	50.9
otals for 1900, quarts	62.7	61.0	58.9	82.0	68.1	68.5
otals for 1901, quarts	109.0	98.0	106.0	129.8	105.0	107.3
ge per year, five crops	73.2	68.8	71.2	84.9	70.0	75.7

Gooseberries—Fertilizer Plots.

VARIETY.	UNIRRIGATED.			IRRIGATED.		
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.	Plot 6.
	oz.	oz.	oz.	oz.	oz.	oz.
ing	1,768.0	1,087.0	1,016.0	1,758.0	977.0	946.0
nbus	995.0	143.0	191.0	866.0	107.0	324.0
hton	1,184.0	888.0	734.0	1,058.0	616.0	602.0
aph	259.0	254.0	147.0	580.0	80.0	315.0
otal	3,556.0	2,327.0	2,088.0	3,762.0	1,780.0	2,187.0
ralent in quarts	151.8	99.0	88.9	160.1	75.7	93.1
otals for 1898, quarts	29.7	22.9	26.4	37.5	21.8	24.8
otals for 1899, quarts	36.3	47.5	74.6	70.6	59.5	66.2
otals for 1900, quarts	158.7	96.2	125.0	161.9	128.4	134.5
otals for 1901, quarts	47.2	34.9	31.8	44.2	40.6	45.0
ge per year, five crops	94.6	60.5	69.2	94.9	64.2	72.7

Calculating these figures to the basis of one acre, and averaging, we would have from plants yielding at this rate 4,695.3 quarts in the one case, and only 1,289.1 in the other. These figures include, in averaging, the first two years of fruiting, and are much smaller than if these years were not included, though the relations would be practically the same. Taking the four best plants as the basis for calculating, we would have yields of 5,319.2 quarts per acre.

As a general law in plant growing, "like begets like," hence the great importance, as the facts presented show, of taking cuttings for propagation only from bushes of known producing power when we wish to increase and maintain productive currant plantation. We have a lot of plants under way taken from these several bushes.

Considering the results from the different plots in 1902, we have:

(*a*) An increase on two of the three plots irrigated. Combined, the increase over the unirrigated plots equals over 3 per cent.

(*b*) Plot 1, manure, unirrigated, and plot 6, chemical mixture, with nitrate, irrigated, have the largest yields.

(*c*) Where not irrigated the plot receiving the extra nitrate is second, and where irrigated, first in yields.

In the same manner, considering the average of the five crops harvested, we have:

(*a*) An increase, in all cases where irrigated, equaling together 10.76 per cent.

(*b*) Plots 1 and 4, manure, are first, and 3 and 6, chemical mixture, with nitrate, second in yield.

(*c*) The nitrated plots stand second in yield.

Gooseberries.—Combining the yields in the five crops upon all plots of the different varieties, we have the following comparative yields per acre of the different sorts:

Downing	**7,955.3 quarts.**	**Columbus**	**2,739.4 quarts.**
Houghton	**8,819.9 "**	**Triumph**	**2,499.9 "**

The plot work of 1902 shows that—

(*a*) The irrigated plots have the larger yield in two of the three cases; combined, however, the unirrigated plots have the larger yield by a little over 3 per cent.

(*b*) Plots 1 and 4 (manure) have by far the largest product.

(*c*) Where unirrigated the nitrate plot is lowest, and where irrigated, second in order of yield.

Similarly, for the average annual crop, we have—

(*a*) An increase upon the irrigated plots, in all cases, equaling together together 3.3 per cent.

(*b*) Manure upon plots 1 and 4 has given much the larger product, exceeding the next plots in order over 33.5 per cent.

(*c*) Where extra nitrate of soda is added, plots 3 and 6, an increase is given over those plots treated identically, excepting the application of nitrate of soda, equaling 13.8 per cent.

STRAWBERRIES.

The beds fruiting this year were set originally in August, 1899. In 1900 fruit was obtained only from the first plants set. Good matted rows were formed for fruiting in 1901. After harvesting the crop in 1901 the spaces between the rows were cut out, leaving a strip about fifteen inches wide along the original row. This strip was thoroughly cleaned out and spaces between rows worked up, and the bed left for fruiting another season.

April 28th and May 19th, fertilizers, as outlined, were applied. Three applications (May 26th, June 4th and 13th) of water were made upon plots 5 to 8, inclusive, giving one inch, one and one-half inches and one inch, respectively.

The results of the year's work are given in Table 9, together with the totals and averages of the previous crops grown upon the fertilizer plots.

The yields obtained are small, particularly on the lower end of the patch or plots 4, 7 and 8, where the plants did not grow well after cleaning out in 1901.

The following figures show the comparative yields of the six varieties grown, and includes the five crops, large and small together. Yields are per acre, in quarts:

Sharpless	1,935.0	Glen Mary	*4,474.9
Bubach	4,491.6	Gandy	3,100.8
Downing	2,788.5	Marshall	2,567.2

* Three crops only.

TABLE 9.

Strawberries—Fertilizer Plots.

VARIETY.	Date first picking.	UNIRRIGATED.							
		PLOT 1.		PLOT 2.		PLOT 3.		PLOT 4.	
		Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Sharpless	June 4.	49.5	230.0	47.5	222.0	33.0	176.0	5.5	81.0
Bubach	May 29.	71.5	286.0	81.0	273.0	18.0	279.0	6.0	186.0
Downing	" 29.	32.0	205.0	26.5	166.0	20.0	161.0	12.5	127.0
Glen Mary	" 29.	39.0	301.0	26.5	249.0	9.0	138.0	8.0	169.0
Gandy	June 6.	37.0	244.0	12.5	190.0	16.0	204.0	9.0	111.0
Marshall	May 29.	36.5	239.0	23.5	172.0	17.0	191.0	9.0	90.0
Total		265.5	1,505.0	217.5	1,272.0	113.0	1,149.0	50.0	764.0
Equivalent in quarts		14.0	79.2	11.4	66.9	5.9	60.5	2.6	40.2
Totals for 1897, quarts		16.4	86.2	14.5	91.2	12.1	81.0	12.3	78.6
Totals for 1898, quarts		26.0	64.7	24.9	58.5	20.2	42.4	17.0	36.3
Totals for 1900, quarts		7.5	25.5	8.9	26.9	6.6	17.1	5.0	15.0
Totals for 1901, quarts		27.1	128.6	28.9	133.9	19.9	125.5	18.1	133.3
Average per year, five crops		18.2	76.8	17.7	75.5	12.9	65.3	11.0	60.7

Strawberries—Fertilizer Plots.

VARIETY.	Date first picking.	IRRIGATED.							
		PLOT 5.		PLOT 6.		PLOT 7.		PLOT 8.	
		Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.	Yield first three pickings.	Total yield.
		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Sharpless	June 4.	31.5	158.0	33.5	148.0	22.5	90.0	9.5	43.0
Bubach	May 29.	68.5	451.0	79.5	379.0	37.0	282.0	33.0	232.0
Downing	" 29.	33.0	228.0	16.5	124.0	13.0	108.0	12.5	87.0
Glen Mary	" 29.	36.0	361.0	18.5	273.0	15.0	229.0	11.5	126.0
Gandy	June 6.	21.0	274.0	7.5	188.0	9.5	85.0	5.5	94.0
Marshall	May 29.	16.5	149.0	7.0	64.0	1.0	48.0	3.5	85.0
Total		211.5	1,611.0	102.5	1,116.0	98.0	812.0	[illegible]	728.0
Equivalent in quarts		11.1	84.8	8.6	58.7	5.2	42.7	4.5	38.3
Totals for 1897, quarts		16.8	76.8	12.8	56.1	16.1	82.8	17.8	57.9
Totals for 1898, quarts		27.6	61.5	26.0	62.6	25.4	49.2	20.7	43.3
Totals for 1900, quarts		5.6	19.1	7.6	20.8	7.7	20.4	6.4	17.4
Totals for 1901, quarts		19.1	105.6	28.8	120.6	19.1	94.8	21.6	126.1
Average per year, five crops		16.0	69.6	16.6	63.7	14.7	58.0	14.2	62.0

Taking the results by plots, we have—

(*a*) An increase is obtained where irrigated only on plot 8, early yield, and on plot 5, total yield.

(*b*) Plots 1 and 5 have given the largest yields in both the early and total product. The complete fertilizer has given better results than has the mixture of bone, potash and acid phosphate.

(*c*) The complete fertilizer alone has given larger yields than where nitrate of soda was added on plots 2 and 6. Nitrate added to the other mixture (plots 3 and 7) has given an increase in all cases.

In the average annual crop we have—

(*a*) An increase under irrigation on two plots, early yield, and one plot in the total yields.

(*b*) Excepting plot 6, early yield, plots 1 and 5 have given the largest yield throughout. The complete fertilizer has given better yields than has the mixture used on plots 3, 4 7 and 8.

(*c*) Nitrate of soda added to the complete fertilizer gives an increase on plot 6, early yield, only. Added to the mixture of bone, potash and acid phosphate an increase is given in all cases, excepting plot 7, total yield, where plot 8, the mixture alone, has the larger yield.

THE TREE FRUITS.

The general plan follows: The plots extend crosswise the rows, so that each plot includes two trees of each row; each row being a different variety. A cross line of trees is set between plots, to separate the plots and prevent interfeeding, and at the same time test some of the newer varieties of the different fruit trees. Thus arranged, trees 1, 2, 4, 5, 7, 8, 10 and 11 of each row are included in the plots, while 3, 6, 9 are varieties. Table 10 shows in detail the plan for fertilizers, amounts and times of application.

TABLE 10.

Showing Fertilizer, Amounts and Time of Application for the Various Fruit Trees.

KIND OF FRUIT.	Plot 1.	Plot 2.	Plot 3.	Plot 4.
Apples...........	Nothing.	500 lbs.‖ B. P. & A. P.† applied in spring.	500 lbs. B. P. & A. P. applied in spring.	
Peaches...........	Nothing.	500 lbs. B. P. & A. P. applied in spring.	500 lbs. B. P. & A. P. applied in spring; 150 lbs. nitrate soda applied early and turned under	500 lbs. P. & A. P.‡ applied in spring; 150 lbs. nitrate soda applied early and turned under.
Standard Pears.....	Nothing.	500 lbs. B. P. & A. P. applied in spring.	500 lbs. B. P. & A. P. applied in spring; 150 lbs. nitrate soda applied early and turned under.	
	Plots 1 and 4.*	Plots 2 and 5.	Plots 3 and 6.	
Dwarf Pears........	Nothing.	500 lbs. B. P. & A. P. applied in spring.	500 lbs. B. P. & A. P. applied in spring; 150 lbs. nitrate soda applied early and turned under.	
	Plots 1 and 3.*	Plots 2 and 4.		
Plums.......... Cherries..........	500 lbs. B. P & A P. applied in spring.	500 lbs. B. P & A. P. applied in spring; 150 lbs. nitrate soda applied early and turned under.		

‖ The quantities of fertilizers given are in all cases the amount per acre to be applied.

† An even mixture of ground bone, muriate of potash and acid phosphate.

‡ A mixture of muriate of potash and acid phosphate in the proportion of 1 lb. of the former to 2 lbs. of the latter.

* Plots 1, 2 and 3, Dwarf Pears, and 1 and 2, Plums and Cherries, are irrigated as occasion demands.

The orchards were pruned as needed during March. On May 9th nitrate of soda was applied to all plots, as per plan, and the ground plowed. The general application of fertilizers was made May 21st. The plots to be irrigated as needed (plots 1 and 2, plums and cherries, and 1, 2 and 3, dwarf pears) received two inches of water June 5th.

PLUMS AND CHERRIES.

ombard and Newman, of the plums, were well loaded with fruit, e the other two varieties bore a fair quantity. Brown rot was troublesome this season. The trees were sprayed early, before started, with strong Bordeaux; later spraying, with the mix- sufficiently weak to not injure the foliage, seemed to have little t in controlling the rot, so that, finally, picking off the affected was resorted to. In all cases of trees in the plot work, this n fruit was weighed and the amount taken from each tree given he tables separately from the good fruit obtained. Newman is ly affected by the rot, but the excessive rainfall caused consider- of the fruit to crack in the later pickings. This was separately hed and is given in the table as culls.

he ice storm of February 22d did considerable damage to the orchard, particularly the Newman variety. Hardly a tree of variety escaped injury and some were severly broken, though had to be removed. Of the other varieties, only one tree was ely broken—*i. e.,* tree 1, plot 1, Lombard.

the cherries, Early Richmond gave a good crop, with a fair one ouis Phillippe, and only a little on the Large Montmorency.

he records of the year, together with the totals per tree for the previous crops, and the total yield per plot to date, are given in e 11.

finite conclusions are not warranted, because of the shortness of fruiting life of the trees, and because of the variations existing een trees of the same variety, particularly with the Newman .

he first tree of this variety in plot 1, with the three main branches ved as the result of the ice storm, gave almost ninety pounds of , while tree 1, plot 4, broken but slightly, gave only thirty-five one-half pounds.

ee 2, plot 1, Lombard plum, gave 144 pounds, while tree 2, plot ve only 18½ pounds. Tree 1, plot 1, Early Richmond cherry, 8½ pounds, while tree 2, plot 2, gave 38½ pounds. Variations his nature are noticeable throughout, and occur upon the same year after year.

TABLE 11.

Plums and Cherries—Fertilizer Plots.

VARIETY.	Date marketable.	IRRIGATED.				UNIRRIGATED.			
		PLOT 1.		PLOT 2.		PLOT 3.		PLOT 4.	
		TOTAL YIELD.		TOTAL YIELD.		TOTAL YIELD.		TOTAL YIELD.	
		Tree 1.	Tree 2.	Tree 1.	Tree 2.	Tree 1.	Tree 2.	Tree 1.	Tree 2.
Plums.		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Lombard—Good....	Aug. 26.	85— 3	115— 5	60— 4	88—13	56— 3	54— 7	89—12	19— 5
Lombard—Rotten ..	....	12—12	29— 1	41— 5	49— 8	25— 2	30— 8	35—14	8— 1
Newman—Good.....	Aug. 3.	74— 1	119— 6	42—12	86—11	143—15	87— 4	31— 6	28— 5
Newman—Culls.....	....	15—10	20— 4	3— 1	46—15	53— 7	5—12	4— 1	3— 1
Shropeshire Damson—Good..........	Sept. 2.	0— 6	0— 1	21— 8	19—13	23— 4	12— 1	19—15	11— 7
Shropeshire Damson—Rotten........	....	0— 8	....	7— 4	5— 6	8— 2	3—11	5— 5	4—12
Grand Duke—Good	Sept. 12.	3— 5	10— 0	3— 5	5— 9	6— 2	3— 1	2—10	3— 7
Grand Duke—Rotten.......................	....	2—13	4—13	3— 2	3— 3	2—15	1— 8	2—11	1—12
Totals, per plot..	....	434—13	....	433— 7	....	517— 6	....	[illegible]— 0	——
Totals, three crops, 1899, 1900, 1901.......	....	43— 2	95—10	57—12	102— 1	198— 5	51—10	24— 7	13—14
Totals, per plot, to date, four crops............	....	578— 9	....	658— 4	....	762— 5	....	276— 5	——
Cherries.									
Large Montmorency..................	June 24.	0— 5	1— 4	0— 2	0— 7	0— 7	0— 3	1—11	0—14
Louis Philippe.......	" 18.	1— 3	3— 6	5—11	3— 3	2—11	0— 8	3—11	2— 3
Early Richmond...	" 16.	3— 8	21— 3	19— 5	33— 7	21— 6	21—12	3—13	16— 5
Totals, per plot..	....	35—13	....	67— 2	....	46—15	....	33—12	——
Totals, three crops, 1899, 1900, 1901......	....	2— 4	17—15	6—15	17—14	12— 6	18—13	3— 6	9— 4
Totals, per plot, to date, four crops............	....	56— 0	....	91—15	....	78— 2	....	51— 6	——

With these facts in mind, and considering only the four years' totals, the irrigated plots have given considerably larger yields than those unirrigated. Irrigation seemed to delay ripening, noticeable chiefly upon the Lombard plum, where the irrigated plots were picked six days later, and then were not as mature as the fruits picked from the trees unirrigated. Nitrate of soda added early and turned under when irrigated, plot 2, has given the larger yield, but where unirrigated, plot 4, it is the lowest in yield.

eties.—The records of the varieties are given in table 12, and
the yields to date, as well as that of the season of 1902. Bur-
of the plums, is the most productive sort, with Abundance
in order. Satsuma Blood is the third in order. It has the
ion of being quite irregular in fruiting.

he cherries, Montmorency Ordinaire and English Morello are
productive of the acid fruits characteristic of this class of
s. Of the two Duke's, May Duke is the earlier and more pro-
. Reine Hortense stands by itself; the fruit is large, bright
icy and nearly sweet. Tree 1 has made a good growth and is
roductive. The second tree is barely half the size of tree 1.

TABLE 12.

Plums and Cherries—Varieties.

VARIETY.	Date marketable.	CROP 1902. TOTAL YIELD.		YIELD TO DATE. TREES SET SPRING 1896.	
		Tree 1.	Tree 2.	Tree 1.	Tree 2.
Plums.		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Gage	Aug. 28.	2—12	....	2—12	....
	" 16.	0—12	0— 9	0—12	0— 9
reen Gage	Sept. 6.	23— 5	13— 1	25—15	17— 8
	Aug. 5.	109—14	55— 5	114—12	67— 0
ce	" 5.	51— 1	45— 1	52— 1	45— 8
amson	Sept. 2.	2— 4	0—12	2— 4	1— 9
Blood	Aug. 22.	47—12	41—10	48— 1	42— 7
Cherries.					
	June 18.	2—15	4— 2	7—12	9— 0
ke	" 24.	3— 9	6— 0	14—14	8— 1
orello	" 28.	26— 5	22— 9	47—13	39—15
ency Ordinaire	" 24.	20—10	23—10	41— 8	58— 8
rtense	" 16.	16— 4	0— 6	19— 1	1— 3
e	" 11.	20— 1	6— 5	21—15	6—15

DWARF PEARS.

The two dwarf varieties, Lawrence and Bartlett, gave this year a fair quantity of fruit. Of the dwarfs, by cutting a few of the Lawrence and Bartlett trees, gave a little fruit, with the Keiffer yielding quite heavily. The records of the year, together with the previous yields per tree and the yields to date per plot, are given in table 13.

Definite conclusions should not be drawn, yet the results are quite interesting. Of the crop of 1902, plot 1, no fertilizer, but irrigated, has the largest yield, with plot 4, no fertilizer, and unirrigated, lowest. Plots 3 and 6, receiving the nitrate of soda early, and turned under, have the largest yields (plot 1 excepted in total yield), with the average size per fruit, three-fourths of an ounce, where irrigated, and and one-fourth of an ounce, where not irrigated, larger than on any other plot.

In the total yields to date the irrigated plots have by far the larger yield, but the results by plots are exactly reversed. Plot 1, no fertilizer, is the lowest where irrigated, and its duplicate highest where unirrigated. Plot 3, fertilizer, with nitrate, is highest where irrigated and the duplicate lowest where unirrigated. Plots 3 and 6 have, however, the largest average per fruit.

Varieties.—The yields of the varieties in 1902 and to date are given in Table 14. Theft reduced the yield in one case—*i. e.*, Clairgeau very materially, we know, but as to losses from this cause in other cases we do not know. Of the dwarfs, White Doyenne, and of the dwarfs by cutting, Le Conte, have given the largest yields to date.

VARIETY.	IRRIGATED.																	
	PLOT 1.						PLOT 2.						PLOT 3.					
	TREE 1.			TREE 2.			TREE 1.			TREE 2.			TREE 1.			TREE 2.		
	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.
Dwarfs.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.
Lawrence	45	11—15	4.24	10	2—5	3.70	14	3—12	4.29	15	3—11	3.93	5	1—5	4.20	9	2—15	5.22
Bartlett	......	....	......	1	0—9	9.00	......	....	......	8	3—10	7.28	32	16—3	8.09	32	13—14	6.94
Dwarfs by Cutting																		
Lawrence	3	0—10	3.33	9	2—11	4.78	......	....	......	......	....	......	......	....	......	5	1—7	4.60
Bartlett	......	....	......	......	....	......	......	....	......	......	....	......	......	....	......	......	....	......
Keiffer	164	38—12	3.78	14	4—15	5.64	53	18—9	5.60	30	10—5	5.50	25	9—11	6.20	42	14—13	5.64
Totals, per plot	246	61—13	4.02	......	....	......	120	39—15	5.33	......	....	......	150	60—4	6.43	......	....	......
Totals, two crops, 1900 and 1901	92	27—6	4.76	8	2—2	4.25	70	20—9	4.70	137	40—2	4.69	82	25—11	5.01	69	20—13	4.82
Totals, per plot, to date, three crops	346	91—5	4.22	......	....	......	327	100—10	4.92	......	....	......	301	106—12	5.67	......	....	......

TABLE 18—Continued.

Dwarf Pears—Fertilizer Plots.

VARIETY.	UNIRRIGATED.																	
	PLOT 4.						PLOT 5.						PLOT 6.					
	TREE 1.			TREE 2.			TREE 1.			TREE 2.			TREE 1.			TREE 2.		
	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.
Dwarfs.		lbs. oz.	oz.		lbs. oz.	oz		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.
Lawrence	16	5— 0	5.00	......	....	......	12	2— 5	3.08	1	0— 6	6.00	44	10—12	3.90	14	5— 0	5.71
Bartlett	......	....	......	3	1— 5	7.00	3	0—11	3.67	1	0— 8	8.00	24	10— 1	6.71	7	1—12	4.00
Dwarfs by Cutting.																		
Lawrence	......	....	......	......	....	......	......	....	......	......	....	......	2	0— 9	4.50	2	0— 9	4.50
Bartlett	4	1— 3	4.75	......	....	......	......	....	......	......	....	......	5	1— 4	4.00	......	....	......
Keiffer	57	18—12	5.26	20	6— 0	4.80	22	6—14	5.00	69	22— 6	5.19	32	13—13	6.91	16	5— 8	5.50
Totals, per plot	100	32— 4	5.16	......	....	......	108	33— 2	4.91	......	....	......	146	49— 4	5.40	......	....	......
Totals, three crops, 1900 and 1901	122	39—10	5.20	66	18— 1	4.38	32	9—11	4.84	120	36— 5	4.47	28	11— 2	4.68	......	....	......
Totals, per plot, to date, three crops	222	69—15	5.00	......	....	......	270	79— 2	4.69	......	....	......	154	60— 6	5.22	......	....	......

VARIETY.	Date marketable.	CROP 1902.						YIELD TO DATE—TREES SET SPRING 1896.					
		TREE 1.			TREE 2.			TREE 1.			TREE 2.		
		Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits	Weight.	Average per fruit.
Dwarfs.			lbs oz	oz.		lbs. oz.	oz.		lbs. oz	oz.		lbs. oz	oz.
Margaret	Aug. 11.	13	2—2	2.62	41	8—6	3.27	13	2—2	2.62	72	14—11	3.26
Clapp's Favorite	" 11.	2	1—0	8.00	3	0—15	5.00	5	1—15	6.20	5	1—10	5.20
Howell	....	1	0—4	4.00	4	0—14	3.50	31	7—0	3.61	18	5—1	4.50
Angouleme	Sept. 16.	1	0—9	9.00	....	....	....	10	5—13	9.30	4	2—13	11.25
White Doyenné	" 16.	22	7—13	5.68	13	5—9	6.85	32	10—9	5.28	37	10—15	4.73
Seckel	....	....	....	....	4	1—2	4.50	8	1—3	2.38	6	1—9	4.17
Dwarfs by Culting.													
Le Conte	Sept. 16.	22	8—5	6.05	15	5—1	5.40	58	21—5	5.88	37	12—15	5.59
Clairgeau	" 10.	4	3—0	12.00	....	....	....	5	3—4	10.40	4	1—15	7.75
Belle Lucretine	" 3.	....	....	....	24	7—11	5.13	....	....	....	33	10—12	5.21
Margaret	Aug. 26.	2	0—11	5.50	....	....	....	2	0—11	5.50	....	....	....
Howell	....	....	....	....	....	....	....	7	1—3	2.71	....	....	....

STANDARD PEARS.

The Keiffer trees were this year filled with fruit, with many of the Lawrence and Bartlett trees carrying a fair amount. Table 15 contains all data as in previous cases.

Plot 2, receiving fertilizer, has given the largest yield, with plot 3, the duplicate of 2, with the addition of nitrate of soda, applied early and turned under, lowest in yield. The blank plot, No. 1, stands second in yield.

Varieties.—Table 16 contains the records to date, and are chiefly a matter for record.

TABLE 15.

Standard Pears—Fertilizer Plots.

VARIETY.	PLOT 1.						PLOT 2.						PLOT 3.					
	TREE 1.			TREE 2.			TREE 1.			TREE 2.			TREE 1.			TREE 2.		
	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.
		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz	oz.
Lawrence	5	1—10	5.20	6	2— 8	5.33	10	2— 6	3.80	10	2—14	4.60	7	1—11	3.86	19	6— 0	5.05
Bartlett	......	....	....	17	6— 0	5.65	49	23— 4	7.59	8	3— 8	7.00	12	5— 4	7.00	26	11— 4	6.92
Keiffer	282	78—10	4.46	219	61—13	4.52	121	51— 1	6.75	381	128— 8	5.38	176	62— 8	5.65	111	42— 4	6.09
Sheldon	6	2—15	7.83	......	....	....	......	....	....	......	....	....	......	....	....	......	....	....
Seckel	1	0— 4	4.00	9	2— 0	3.56	......	....	....	......	....	....	......	....	....	......	....	....
Totals, per plot	445	155— 7	4.56	......	....	....	579	211— 4	5.84	......	....	....	351	128—10	5.86	......	....	....
Totals, two crops, 1900 and 1901	142	49— 7	5.57	251	86—10	5.52	125	40—10	5.20	212	71—12	5.42	187	66— 7	5.68	177	62— 8	5.62
Totals, per plot, to date, three crops	838	291— 8	5.57	......	....	....	916	323—10	5.65	......	....	....	715	257— 4	5.76	......	....	....

TABLE 16.

Standard Pears—Varieties.

VARIETY.	Date marketable.	CROP OF 1902.						YIELD TO DATE. TREES SET SPRING 1896.					
		TREE 1.			TREE 2.			TREE 1.			TREE 2.		
		Number of fruits.	Weight.	Average per fruit	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.	Number of fruits.	Weight.	Average per fruit.
			lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz.	oz.		lbs. oz	oz.
Koonce..	....	......	....	.....	......	....	......	......	....	......	10	2— 6	3.80
P. Barry.....	Sept. 16.	......	....	......	9	4—13	8.56	21	6—14	5.24	29	12— 0	6.62
Dorset...............	" 16.	1	0— 6	6.00	39	14— 1	5.77	5	1— 9	5.00	49	16—12	5.47
Angel...............	Aug. 27.	44	18— 4	6.64	3	1— 0	5.33	58	28— 3	6.40	14	8— 9	4.67
Winter Nelis......	Sept. 16.	......	....	......	18	2—11	3.81	26	5—15	3.65	20	4— 8	3.60
Lady Clapp........	Aug. 20.	1	0— 5	5.00	......	....	......	11	3— 5	4.82	......	....	—

PEACHES.

The ice storm of February 22d did considerable damage to the peach orchard. Seven trees were so much injured that they were removed and new ones set. Many of the others had large branches split and bent over. In several cases these were drawn back into place and bolted, and in others removed entirely. Of the trees in plots, tree 2, plot 1, in both Elberta and Crawford's Late, and tree 1, plot 2, Reeve's Favorite, were removed. The varieties Wonderful and Butler's Late also had to be taken out. The following newer sorts were set in places thus made vacant: two trees each of Alexander, Chair's Choice and Foster, and one tree of Wonderful. This last sort was originally included, and, as it seemed a desirable late variety, one tree was reset for further observation.

Table 17 contains the data of the year's work, together with the average annual yield of the four crops taken from the plantations.

Peaches—Fertilizer Plots.

VARIETY.	PLOT 1.													
	TREE 1.							TREE 2.						
	TOTAL YIELD.							TOTAL YIELD.						
	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.
		lbs. oz		oz.		oz.			lbs oz.		oz.		oz.	
Susquehanna	399	75— 2	82.8	3.4	15.9	2.2	746	285	49— 0	78.8	3.4	19.2	1.8	580
Stevens' Rareripe	1,282	78— 8	....	....	87.2	1.0	1,956	609	58— 0	....	....	90.4	1.6	1,105
Elberta	749	97— 7	51.3	2.5	46.1	1.9	1,671	....	....	....	....	....	....	....
Crawford's Late	314	29— 5	2.1	2.5	90.0	1.6	698	....	....	....	....	....	....	....
Reeve's Favorite	380	48— 8	30.4	2.6	65.8	1.9	405	....	....	....	....	....	....	....
Old Mixon	965	104— 0	11.8	2.4	85.8	1.7	1,292	784	74—12	19.8	2.6	76.6	1.5	1,075
Totals, per plot	7,110	784— 9	32.8	2.8	62.5	1.6	12,292	....	....	....	....	....	....	....
Average totals, four crops	5,101	612—11	48.6	2.9	50.7	1.6	4,645	....	....	....	....	....	....	....
Totals, per plot, excluding Stevens' Rareripe	5,269	658— 6	39.4	2.8	57.2	1.7	9,231	....	....	....	....	....	....	....
Average totals, four crops	3,606	485— 8	49.6	2.9	45.6	1.8	3,407	....	....	....	....	....	....	....

TABLE 17—Continued.

Peaches—Fertilizer Plots.

VARIETY.	PLOT 2.													
	TREE 1.							TREE 2.						
	TOTAL YIELD.							TOTAL YIELD.						
	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.
		lbs. oz.		oz.		oz.			lbs. oz.		oz.		oz.	
Susquehanna	254	38— 8	64.7	3.2	30.9	1.8	581	192	17—4	2.5	2.8	78.9	1.6	200
Stevens' Rareripe	336	29—14	....	....	86.2	1.5	625	548	57—9	....	....	91.1	1.7	1,158
Elberta	154	21— 1	57.6	2.7	37.4	1.9	366	174	25—2	55.5	2.9	40.0	2.0	368
Crawford's Late	361	41— 0	13.9	2.6	83.9	1.8	677	344	45—7	39.5	2.5	59.0	1.9	496
Reeve's Favorite	....	....	....	....	....	....	....	700	118—6	68.2	2.9	29.8	2.1	641
Old Mixon	664	88—12	24.2	2.6	72.2	2.1	745	1,012	181—9	41.2	2.5	55.6	1.9	1,065
Totals, per plot	5,434	722— 9	42.2	2.8	53.5	1.9	7,558	....	....	....	....	....	....	....
Average totals, four crops	4,408	551— 8	45.3	2.5	49.6	1.8	3,219	....	....	....	....	....	....	....
Totals, per plot, excluding Stevens' Rareripe	4,555	636— 2	48.6	2.8	48.6	2.0	5,780	....	....	....	....	....	....	....
Average totals, four crops	3,330	456— 2	49.4	2.6	45.9	1.9	2,476	....	....	....	....	....	....	....

TABLE 17—Continued.

Peaches—Fertilizer Plots.

VARIETY.	PLOT 3.													
	TREE 1.							TREE 2.						
	TOTAL YIELD.						Number thinnings.	TOTAL YIELD.						Number thinnings.
	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.		Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	
		lbs. oz.		oz.		oz.			lbs. oz.		oz.		oz.	
Susquehanna	43	11— 9	98.5	4.6	5.4	2.5	81	193	27— 3	49.0	3.0	46.2	2.0	290
Stevens' Rareripe	824	80— 6	....	....	63.2	1.6	1,797	470	47— 6	6.6	2.0	52.4	1.5	801
Elberta	390	66— 2	71.0	3.2	23.5	2.1	516	356	65— 0	76.7	3.4	15.0	2.1	337
Crawford's Late	392	57— 2	49.6	3.0	48.6	1.9	546	448	60—13	41.5	2.6	57.7	1.9	616
Reeve's Favorite	379	69—11	79.3	3.3	17.8	2.1	361	650	120— 4	75.0	3.2	24.1	2.4	585
Old Mixon	995	117— 9	19.5	2.5	77.7	1.8	1,160	1,304	163—11	28.4	2.7	67.0	1.9	1,415
Totals, per plot	6,444	886—12	44.3	3.1	47.2	1.9	8,455	....	....	....	....	....	....	....
Average totals, four crops	4,700	654—13	45.6	3.0	47.3	2.0	3,977	....	....	....	....	....	....	....
Totals, per plot, excluding Stevens' Rareripe	5,150	759— 0	51.3	3.1	45.3	1.9	5,857	....	....	....	....	....	....	....
Average totals, four crops	3,443	499— 7	52.6	3.0	42.0	2.0	2,706	....	....	....	....	....	....	....

TABLE 17—Continued.

Peaches—Fertilizer Plots.

VARIETY.	PLOT 4.													
	TREE 1.							TREE 2.						
	TOTAL YIELD.							TOTAL YIELD.						
	Number of fruits.	Weight.	Per cent. No. 2 fruit.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.	Number of fruits.	Weight.	Per cent. No. 1 fruits.	Average per fruit.	Per cent. No. 2 fruits.	Average per fruit.	Number thinnings.
		lbs. oz.		oz.		oz.			lbs. oz.		oz.		oz.	
Susquehanna	96	24— 8	98.6	4.8	4.9	2.7	245	76	16— 7	84.0	4.0	11.8	2.2	280
Stevens' Rareripe	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Elberta	581	108— 1	80.5	3.2	16.7	2.1	986	289	58—14	68.9	3.8	26.8	2.1	728
Crawford's Late	748	110—13	53.8	2.8	38.9	2.1	1,385	183	87— 0	85.7	3.5	11.3	2.3	248
Reeve's Favorite	697	128— 7	76.2	3.2	22.8	2.1	870	390	92— 8	96.5	4.6	3.4	2.5	338
Old Mixon	1,097	158—14	80.2	2.7	66.2	2.2	1,381	812	105— 9	87.0	2.5	50.1	2.0	347
Totals, per plot	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Average totals, four crops	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Totals, per plot, excluding Stevens' Rareripe	4,969	891— 1	63.9	3.3	38.3	2.1	5,798	....	....	....	....	....	....	....
Average totals, four crops	2,000	503— 4	65.5	3.3	30 4	2.1	2,684	....	....	....	....	....	....	....

In those cases where one tree of a variety in a plot is out, the yield of the tree remaining is doubled in getting the totals for that plot, so that in all cases the totals given are for a full plot of 12 trees.

The method of taking the records has been the same in this as in previous years—*i. e.*, sorting into firsts, seconds and culls, but instead of giving the records as made, only the total yield is given, with the percentages of firsts and seconds, with the average size of the same in each case.

The first totals given are to be used in comparing the first three plots only. The second, excluding Stevens' Rareripe, are to be used in comparing all four plots.

In the last report* attention was called to the marked variations occurring between different trees of the same variety, both as regards quantity of fruit produced and the proportion of the same grading firsts. Similar variations upon the same trees are in evidence this year.

Considering the first three plots—*i. e.*, plot 1, check, plot 2, even mixture bone, potash and acid phosphate, and plot 3, same as 2, with nitrate of soda added early and turned under, the results of the crop of 1902 and the annual four years' average are the same.

Plot 1 has set the most fruit; more has been removed in thinning and still more left on the tree to ripen than on either the other plots. The weight of fruit, however, is exceeded by that from plot 3, but it exceeds that from plot 2. The percentage of fruits, grading firsts, is larger upon plot 3 and lowest on plot 1. The average weight per fruit is likewise larger upon plot 3 than upon either the other two plots.

Plot 4 received a mixture of potash and acid phosphate, one part potash to two parts of acid phosphate, with nitrate of soda applied early and turned under. Taking the totals from the same plots—Stevens' Rareripe excluded—the result of the 1902 crop and the four-year average practically agree. The result of the first three plots likewise agree with the totals from these plots when Stevens' Rareripe is included.

Plot 1 has set the largest number of fruits; more has been removed in thinning, still leaving more upon the tree to ripen than upon any other plot. The yield of fruit, however, is largest upon plot 4 and second largest upon plot 3, third upon plot 1 and lowest upon plot 2. The percentage of first grading fruits and the average weight of the same is largest upon plot 4 and second largest upon plot 3.

*Annual Report 1901, page 249.

TABLE 18.

Peaches—Varieties.

VARIETY.	Date marketable.	Tree 1. Number of fruits.	Tree 1. Weight.	Tree 1. Per cent. No 1 fruits.	Tree 1. Average per fruit.	Tree 1. Per cent. No. 2 fruits.	Tree 1. Average per fruit.	Tree 1. Number thinnings.	Tree 2. Number of fruits.	Tree 2. Weight.	Tree 2. Per cent. No. 1 fruits.	Tree 2. Average per fruit.	Tree 2. Per cent. No. 2 fruits.	Tree 2. Average per fruit.	Tree 2. Number thinnings.	Average annual yield, four crops. Total weight.	Average annual yield, four crops. Average per fruit.
			lbs. oz.		oz.		oz.			lbs. oz.		oz.		oz.		lbs. oz.	oz.
Sneed	July 10	283	30— 5	56.1	2.0	86.9	1.4	289	25	1—7	....	....	78.8	1.1	10	*29— 9	1.7
Triumph	Aug. 1	188	8— 8	....	....	54.2	1.8	1,751	306	24—1	10.4	1.8	71.2	1.4	3,020	51—14	1.4
Champion	" 23	755	139— 9	79.4	3.3	16.8	2.2	1,071	654	121—2	77.7	3.3	16.9	2.2	778	199— 2	2.8
Surpasse	" 26	158	34— 0	89.0	3.7	10.7	2.3	324	293	38—6	52.6	2.6	43.2	1.8	415	*51—14	2.6
Crosby	Sept. 10	991	96—11	6.2	2.6	83.8	1.6	2,535	875	51—6	49.8	2.9	44.0	2.0	1,164	182—10	2.0
Ward's Late White	" 22	959	95— 1	6.0	2.5	70.7	1.6	1,998	662	59—9	....	....	70.3	1.5	1,724	148— 4	1.8

* Three crops only.

These two plots (3 and 4) received a dressing of nitrate of soda at the rate of 150 pounds per acre, applied early and turned under. The influence of this extra nitrogen was noticeable throughout the season in the dark green, vigorous foliage. Contrasted with the very dark green of trees on these plots, trees on plot 2 were yellowish and those of plot 1 light green in color.

Varieties.—Table 18 contains the records of the six varieties fruiting in 1902, together with the average annual yield since the trees were set.

Sneed is the earliest fruiting sort, maturing July 10th. One tree has failed to grow properly. The other is fairly productive. It is not a vigorous grower and quite crooked in manner of growth.

Triumph is situated between plots 1 and 2 of the fertilizer plots and shows the lack of proper treatment. It is the second earliest sort.

The table shows the season and productiveness of the other varieties.

APPLES.

This is the first year of fruiting, and Table 19 contains the yields to date of all trees in the fertilizer plots and of the varieties. Plot 1 received no fertilizers and has not been cropped, while plots 2 and 3 have received a mixture of bone, potash and acid phosphate annually and the ground between the trees has been used for the vegetable garden each year since setting. The records of the year are presented only as a matter for record.

TABLE 19.

Apples—Fertilizer Plots and Varieties.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	TREE 1.		TREE 2.		TREE 1.		TREE 2.		TREE 1.		TREE 2.	
	Number of fruits.	Weight.	Number of fruits.	Weight.	Number of fruits.	Weight.	Number of fruits.	Weight.	Number of fruits.	Weight.	Number of fruits.	Weight.
		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz.		lbs. oz		lbs. oz.
Smith's Cider.........	202	40— 1	10	1— 5	91	17— 9	136	22— 8	14	1— 9	43	6—[illegible]
King......................	2	1— 0	8	3— 8	1	0— 7	......	....	3	1— 7	——	——
Jonathan................	1	0— 6	32	6—14	15	3— 7	19	5— 5	——	....	7	1—[illegible]
Oldenburg..............	......	....	10	2— 5	28	5—12	84	14—13	9	1—13	11	2—[illegible]
Varieties.												
Ben Davis......	36	7— 5	67	13— 5	......	....	......	....	......	....	——	——
Yellow Transparent......................	45	6—11	9	1—13	......	....	......	....	......	....	——	——
Williams' Favorite	7	1— 7	......	....	......	....	......	....	......	....	——	——
Barry......................	56	13— 5	1	0— 4	......	....	......	....	......	....	——	——

PEAS, BEANS AND SWEET CORN WITH FERTILIZERS.

In a previous report* the results were given of a fertilizer test with early peas and beans, followed with sweet corn and with crimson clover, sown in the latter as early as possible in August.

Since that report was made the same line of work has been continued upon the same ground, increasing, however, the applications of manures and fertilizers by 50 per cent. and doubling the rows of peas and beans, planting two rows ten inches apart instead of single rows, as in the first test. Each of the five plots are approximately one-twenty-fifth acre in area and are treated as follows:

*Annual Report 1898, page 167.

Plot 1. Check.
" 2. Manure, 15 tons per acre.
" 3. Mixture: { Muriate of potash, 1 lb. / Acid phosphate, 2 lbs. } 788 lbs per acre.
" 4. { Potash and acid phosphate, 788 lbs per acre. / Nitrate of soda, 225 lbs. per acre.
" 5. { Potash and acid phosphate, 788 lbs. per acre. / Nitrate of soda, 75 lbs. per acre. / Dried blood, 225 lbs. per acre.

This plan of plots has been followed for seven seasons, so that plot 1, while growing two crops each year, has had nothing applied to it.

One-half of each plot is planted to peas and the other half to beans. Each year the peas—edible condition—have been harvested, and the vines removed before the corn was planted. With the beans, however, the corn is planted between the rows, since the crop—snap beans—does not mature early enough to remove the vines before necessary to plant the corn. Approximate dates of planting the different seeds each year are—

Peas, Apr il 15th to 20th.
Beans, April 28th to May 4th.
Sweet corn, July 1st to 7th.
Crimson clover, August 10th to 15th.

Good crops of peas and beans have been obtained each year, excepting 1901, when the dry spring cut the pea and bean crop nearly or quite two-thirds.

With one exception, also due to climatic conditions of the season, fair crops of sweet corn have matured the last of September and first of October. In 1899, frost on October 2d cut the crop before the later sorts matured. Other seasons' frosts have held off until the 22d, or later, of October, and the corn has had plenty of time to mature. Crimson clover is hardly satisfactory to use in this connection. While we have been able to secure fair stands, it cannot be sown early enough and give the sweet corn the cultivation that seems desirable; and in spring the land is plowed too early to secure any benefit in spring growth. Some quick-growing fall crop, as rye, would probably be better adapted for furnishing humus to the soil, even though it did not add nitrogen.

Tables 20, 21 and 22 contain the average annual yields of the different sorts of peas, beans and sweet corn, respectively, with the totals for the plots.

TABLE 20.

Peas—Fertilizer Plots.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.				PLOT 4.				PLOT 5.			
	Amount first picking.	Total yield.	Weight, 100 plants.	Total weight, vines.	Amount first picking.	Total yield.	Weight, 100 plants.	Total weight, vines.	Amount first picking.	Total yield.	Weight, 100 plants.	Total weight, vines.	Amount first picking.	Total yield.	Weight, 100 plants.	Total weight, vines.	Amount first picking.	Total yield.	Weight, 100 plants.	Total weight, vines.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Nott's Excelsior	60.5	91.5	9.8	73.0	105.5	169.3	20.4	166.0	80.3	117.0	11.9	96.0	95.0	147.0	17.4	137.0	108.8	147.5	20.1	135.0
Little Gem	37.5	70.0	12.3	76.0	63.0	127.3	25.9	170.0	56.0	90.8	18.4	95.0	71.0	117.3	22.1	130.0	77.0	124.3	26.1	140.0
Premium Gem	58.0	79.3	12.0	69.0	89.8	146.8	20.3	176.0	88.5	115.8	19.3	116.0	82.5	125.0	17.1	125.0	86.3	132.5	20.8	144.0
American Wonder	35.3	48.0	12.0	39.0	57.8	86.5	30.8	92.0	62.5	82.0	24.5	61.0	56.5	74.3	24.0	61.0	66.0	87.5	24.0	74.0
Chelsea	42.0	71.0	10.3	60.0	67.3	127.3	18.5	120.0	62.3	99.8	16.5	79.0	75.0	127.0	16.9	108.0	82.0	125.5	16.8	109.0
O'Rourke	41.0	57.0	6.3	41.0	78.5	129.8	13.1	98.0	58.5	92.3	8.8	60.0	72.0	110.0	9.9	78.0	71.8	118.0	9.8	74.0
Tom Thumb	30.0	64.3	10.1	68.0	49.5	106.5	13.4	128.0	49.3	90.5	11.1	79.0	61.3	118.0	10.3	128.0	67.0	128.0	13.4	114.0
Best Extra Early	49.3	71.3	7.4	54.0	70.0	132.5	9.8	119.0	65.5	98.0	7.6	78.0	80.3	122.3	12.4	87.0	91.8	138.5	14.9	105.0
Alaska	45.5	66.3	7.1	57.0	69.5	124.0	9.0	119.0	51.8	84.3	5.1	70.0	69.8	116.5	9.0	94.0	76.8	126.3	9.8	88.0
Selected Extra Early	39.8	73.0	5.9	59.0	66.3	123.5	8.1	108.0	45.5	74.0	6.8	68.0	67.3	109.8	9.3	88.0	64.5	118.0	11.1	96.0
Totals, per plot	438.9	692.2	98.2	561.0	712.2	1273.5	169.8	1288.0	615.7	989.5	130.0	792.0	730.7	1162.2	148.4	1028.0	787.0	1281.1	166.2	1078.0

Beans—Fertilizer Plots.

VARIETY.	PLOT 1. Amount first picking.	PLOT 1. Total yield.	PLOT 1. Weight, 40 plants.	PLOT 1. Total weight, vines.	PLOT 2. Amount first picking.	PLOT 2. Total yield.	PLOT 2. Weight, 40 plants.	PLOT 2. Total weight, vines.	PLOT 3. Amount first picking.	PLOT 3. Total yield.	PLOT 3. Weight, 40 plants.	PLOT 3. Total weight, vines.	PLOT 4. Amount first picking.	PLOT 4. Total yield.	PLOT 4. Weight, 40 plants.	PLOT 4. Total weight, vines.	PLOT 5. Amount first picking.	PLOT 5. Total yield.	PLOT 5. Weight, 40 plants.	PLOT 5. Total weight, vines.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Currie's Rust Proof Wax.......	44.8	85.3	9.1	135.0	96.3	171.5	15.5	256.0	35.0	74.8	10.8	127.0	61.5	118.0	13.9	208.0	60.5	115.5	12.5	215.0
Refugee Wax..........................	20.8	86.3	11.8	173.0	41.5	182.5	18.3	299.0	18.5	81.0	12.1	147.0	35.0	139.8	13.8	244.0	26.8	105.0	16.5	233.0
Golden Wax..........................	43.3	83.3	14.5	111.0	94.0	172.8	17.5	207.0	34.0	77.3	15.9	113.0	65.5	125.5	22.4	163.0	62.5	119.5	14.3	155.0
Davis' White Wax..	40.5	112.0	14.3	113.0	80.5	228.5	37.6	253.0	34.8	112.0	16.5	154.0	68.8	178.3	19.0	231.0	66.0	174.5	19.8	212.0
Flageolet Wax.......................	44.3	111.0	16.0	179.0	61.8	189.0	25.5	248.0	37.8	106.0	17.9	202.0	51.0	163.5	19.8	247.0	52.8	162.3	24.6	268.0
Early Warwick........................	69.5	108.3	9.9	165.0	106.8	177.5	16.5	280.0	63.5	106.3	12.1	175.0	81.8	152.5	15.6	251.0	90.0	159.0	14.8	265.0
Emperor William..................	18.7	52.0	25.8	77.0	18.3	117.0	45.0	164.0	22.0	85.0	30.5	133.0	22.0	99.3	38.5	158.0	32.7	104.3	44.0	151.0
Stringless Green Pod...........	33.8	67.5	13.4	163.0	68.0	158.8	23.9	327.0	34.5	68.5	16.3	187.0	50.3	111.5	17.1	261.0	51.3	106.5	19.6	276.0
Early Valentine..	29.8	84.3	10.1	149.0	72.5	200.8	19.9	297.0	31.8	102.5	14.5	180.0	37.5	129.8	17.3	233.0	48.0	147.0	15.9	265.0
Ex-Early Refugee..................	22.8	62.0	8.5	157.0	45.0	182.8	16.0	326.0	27.5	71.8	11.6	172.0	36.5	118.5	12.6	265.0	26.8	107.0	13.4	269.0
Totals, per plot............	368.3	847.0	133.4	1422.0	684.7	1726.2	235.7	2657.0	339.4	885.2	158.2	1590.0	509.9	1336.7	190.0	2261.0	517.4	1300.6	195.4	2309.0

TABLE 22.

Sweet Corn—Fertilizer Plots.

VARIETY.	PLOT 1.			PLOT 2.			PLOT 3.			PLOT 4.			PLOT 5.		
	Number of ears.	Weight of ears.	Weight of fodder.	Number of ears.	Weight of ears.	Weight of fodder.	Number of ears.	Weight of ears.	Weight of fodder.	Number of ears.	Weight of ears.	Weight of fodder.	Number of ears.	Weight of ears.	Weight of fodder.
		lbs. oz.	lbs.		lbs. oz.	lbs.		lbs. oz.	lbs.		lbs. oz.	lbs.		lbs. oz.	lbs.
Perry Hybrid	52	18— 8	24.8	70	30— 8	41.8	73	26—15	36.7	74	26— 2	43.5	62	23— 9	34.2
Stablers' Early	54	17—15	33.4	100	39— 6	64.2	66	22— 4	46.8	77	29—15	56.8	65	24—12	49.3
Roslyn Hybrid	73	29— 6	47.1	107	49— 4	78.8	80	36— 4	62.8	83	33— 8	67.7	65	27—13	54.2
Stowell's Evergreen	41	18— 0	46.7	61	28—10	80.2	52	25— 8	69.5	46	23— 5	58.6	45	18— 5	52.7
Country Gentleman	34	9—15	58.1	82	31— 0	93.3	64	23— 5	74.4	60	19—11	65.5	56	16—14	48.5
Totals, per plot	254	93—12	210.1	420	178—12	358.3	335	134— 4	290.2	340	130— 9	292.1	293	111— 4	238.9

ᴾeas.—The early product from the different plots is shown by the ıres in the first column under each plot. In the second and fourth umns in each case is given the total yield of edible peas and the ght of vines removed after harvesting the peas. The weight of) plants at the end of each variety in each plot is also given.

The most productive of the varieties are Nott's Excelsior and ɜmium Gem, of the wrinkled sorts, and Best Extra Early and ıska of the earlier smooth sorts.

The results by plots, all varieties combined, are, briefly—

Plot 5 leads in early yield by 7.7 per cent. Plot 4 is second.
" 2 leads in total yield by 3.4 per cent. Plot 5 is second.
" 2 has largest weight for first 100 plants Plot 5 is second.
" 2 has largest total weight of vines. Plot 5 is second.

ſard manure, plot 2, thus leads in yield in all cases but the early duct. Plot 5 is likewise second throughout. The difference in d in favor of plot 2 over plot 5 is very small, amounting for an ɜ to approximately four and one-fourth bushels. Compared with check plot, the increase is very large, amounting to 84 per cent., l over minerals only, plot 3, the increase equals 35.6 per cent. ıerals alone have given an increase over check plot of 35.7 per cent. ꞌeans.—The tables are similar to that for peas. Of the wax beans, ·is' White and the Flageolet are the most productive, with the ɜr wax sorts very nearly alike in yield. Early Warwick and Early entine are the most productive of the green pod sorts. By plots results, combining all varieties, are—

Plot 2 leads in early yield by over 32 per cent. Plot 5 is second.
" 2 leads in total yield by over 29 per cent. Plot 4 is second.
" 2 has largest weight for first 40 plants. Plot 5 is second.
" 2 has largest total weight of vines. Plot 5 is second.

'ard manure thus leads throughout, with plot 5 second in all ex- ; the total yield, when plot 4 stands second in order. The increase ›lot 2 over 4 in total yield is approximately forty-eight and one- : bushels per acre. Compared with the check plot, the increase 'avor of the manure plot is over 100 per cent., and the increase · minerals equals 95 per cent. Minerals only, plot 3, give but little er yields than does the check plot—*i. e.*, 885 to 847, respectively. lack of nitrogen upon this plot (3) is very plainly evident in color of the foliage and size of the plants. While the plants of

plot 1 show a light greenish color, and are about half the size of those of plot 2, the plants of plot 3, about the same size, are decidedly yellowish in color.

Sweet Corn.—In the table is given the number and weight of the edible ears produced and the weight of the fodder. The selection of varieties has been made to secure a succession. The order of maturing is as given in the table, excepting that the Evergreen comes after the Country Gentleman.

On the lower side of the field the sweet corn has not developed satisfactorily. The table shows that plot 4 gives but little larger yields than obtained upon plot 3, while plot 5 gives considerably less than that from plot 3. Plot 2 leads in yield throughout and with plot 4 second. The percentage increase of 2 over 4 equals 28. Compared with the check plot the increase in yield of ears and fodder of plot 2 equals 91 and 70 per cent., respectively. The increase from minerals only over the check plot is 43 per cent. in yield of ears and 38 per cent. in yield of fodder. In all main particulars the results of this test confirm the results obtained in the first test, previously reported. The relations, however, between the yields of the check plot (No. 1) and the plot receiving minerals only (No. 3) and the yields of the other plots has constantly widened. The rate of decrease, though, has been greater in the check plot than where the minerals only were used in the yields of peas and sweet corn, but with the beans the difference between these two plots have become less and less.

Doubling the number of rows and increasing the amount of manure and fertilizers 50 per cent. has not resulted in a proportionate increase in the yields from the different plots. The very small yield, however, of the one season is included in the average yields given.

PEAS AND TOMATOES—DOUBLE CROPPING.

In the report of 1898 the results were given of a test of double cropping with peas and tomatoes, testing, at the same time, the effect of fertilizers and fertilizers with lime upon our soil. It was stated then that the two crops could be grown very successfully together and that the plot receiving lime with the fertilizer gave a small increase with peas and a considerable increase with tomatoes over the yields obtained with fertilizers alone.

n this test the rows of peas were planted much farther apart than ned necessary and, in continuing the work, the peas were planted he usual distances. The plots were enlarged slightly, so that each :ained approximately one-eighty-sixth acre in area, and are treated ollows:

Plot 1. Check.
" 2. Complete fertilizer, 500 lbs. per acre.
" 3. Complete fertilizer, 500 lbs. per acre, 1½ tons per acre lime, applied in 1896, and again in 1902.

'eas were planted early in the season upon each plot, giving seven ble rows, three feet apart. Only the early dwarf sorts are desirable this purpose. In due time tomato plants were set between every ›r row of peas, giving twenty plants per plot.

'able 23 contains the average annual yields of both peas and atoes.

TABLE 23.

s and Tomatoes—Double Cropping with Fertilizer and Lime.

PLOT.	PEAS. Amount first picking.	PEAS. Total yield.	PEAS. Weight, 200 plants.	PEAS. Total weight of vines.	TOMATOES. Amount first six pickings.	TOMATOES. Total yield marketable fruits.	TOMATOES. Average size per fruit.	TOMATOES. Culls.	TOMATOES. Rotten fruit.
	lbs. oz.	lbs. oz.	oz.	lbs. oz.	lbs. oz.	lbs. oz.	oz.	%	%
1. Blank	28—8	34—15	22.4	33—9	21—5	72—13	4.67	9.8	4.0
2. Fertilizers	28—5	46—10	28.2	47—7	45—8	124—6	4.82	8.4	5.8
3. Fertilizers and lime	24—14	44—8	26.6	45—0	41—7	108—9	4.88	9.8	4.8

'he two crops are very successfully grown upon the same ground. h peas the yields obtained are fully as large as in other cases. With atoes, also, very good yields per plant are obtained. On the acre is the yields are small, because of the greater space given each at, the plants being set four and one-half by six feet, and because, combining another experiment with this, one-half the plants in plot are quite productive, while the other half is much less so.

The yield of plot 2, fertilizers alone, exceeds that of 3, where lime was added. In studying the annual yield, however, the yield of plot 3 is seen to decrease slightly each year, showing that the effect of the lime was rapidly passing away. In the yields of 1902, however, plot 3 has given yields in both peas and tomatoes, exceeding by considerable that from plot 2.

No attempt has been made to grow rye or crimson clover after harvesting the tomato crop, thus adding humus to the soil—a procedure that seems quite desirable.

REPORT OF THE ASSISTANT IN DAIRY HUSBANDRY.

DAIRY HUSBANDRY.

[T]he principal lines of work pursued in this department during the [pas]t year were as follows:

[T]he study of forage crops, including crop rotations, cost and yield [of] forage, and new varieties.

[T]he retail milk business, including the cost of production, sale and [wa]stes in handling and delivery.

[D]aily records have been kept of the dairy herd and the milk of [eac]h animal analyzed semi-monthly, the results of which are reported.

[C]onsiderable time has been given to the analysis of milk by the [Ba]bcock Method" during the past six years, the number of analyses [am]ounting to 10,400. In addition to the regular work in this direc[tio]n, samples are frequently sent to the Station by farmers, dairymen [and] breeders' associations. The number received from these sources [dur]ing the past year amounted to 185 samples of milk and ten samples [of c]ream.

[T]he use of the disk harrow in removing weeds and reseeding alfalfa [wa]s made the subject of an experiment, the results of which are re[por]ted.

[E]xperiments were continued in growing cow peas and corn for [sila]ge.

[A] study was made of the comparative value of forage crops and [sila]ge for dairy cows, covering a period of six years.

[N]itrate of soda as a top dressing for rye, wheat and barnyard millet [wa]s made a subject of study and its effect upon the yield and value [of] the crop noted.

[T]he effect of lime upon land where forage crops have been grown [con]tinuously for a number of years was studied; the crops used being [cow] peas, soy beans and forage corn.

[A] study was made of a number of cover crops and their adapta[bili]ty for different soils and conditions.

Experiences in the use of the "Schmidt Treatment" as a cure for milk fever are noted, four cases being reported.

The dairy business in relation to soil exhaustion has been continued for six years and the results showing the gains and losses to the farm are reported.

Since the last report was issued Bulletin No. 158, "Soiling Crop Experiments," and No. 161, "Alfalfa, Cow Peas and Crimson Clover as Substitutes for Purchased Feeds—Home-Grown Protein versus Purchased Protein," have been published and the following general conclusions were drawn from them:

1. A rotation may be arranged, including crops that thrive well early and late, which will provide a continuous supply of forage for a dairy herd from May 1st to November 1st.

2. The value of a plant for forage is determined by its yield, composition, palatability, season of the year in which it may be grown, time required for it to mature and its effect upon the flavor of milk.

3. The soiling system has the advantage over pasture, in that it provides a uniform supply of succulent food, which is very important in the retail milk business.

4. Three crops can be grown upon the same acre in one season, as, for example, rye, oats and peas and corn, yielding a total of twenty tons or more; with the perennial plant, alfalfa, five crops have been secured, with a yield of 26.6 tons of green forage per acre.

5. The herd consumed an average of sixty pounds of green forage per cow per day, with six to eight pounds of fine feed. In an experiment where green crops were fed exclusively, cows consumed 100 pounds per day of forage of such character as oats and peas.

6. Yearly records have shown that from three to four cows may be kept upon an acre for six months, beginning May 1st, the number depending upon the character of the season.

7. Records for five years show the average yield of milk and butter per cow, during the six months when forage crops were fed, to be 3,423 pounds and 172.7 pounds, respectively. The average percentage of fat in the milk was 4.32.

The same cows yielded an average of 3,050 pounds of milk and 157.4 pounds of butter, during the other six months of the year, when silage was fed. The average percentage of fat from the silage ration was 4.42.

1—*a*. A "home-grown" ration, composed of thirteen pounds of alfalfa hay and thirty pounds of corn silage, proved both practical and

ıomical when fed in comparison with a ration in which over two-'ds of the protein was derived from wheat bran and dried brewers' ins. Milk was produced from the home-grown ration for two-thirds cost of that from the feed ration. The cost of milk per hundred 55.9 cents against 83.9 cents for the feed ration.

. The gain from feeding the home-grown ration, when milk is th $1 per hundred, amounted to $1.99 per cow per month.

. On the basis of this experiment, when mixed hay (timothy and top) sells for $16 per ton, and wheat bran can be purchased for per ton, and dried brewers' grains for $20 per ton, alfalfa hay is th $24.52 per ton as a substitute for mixed hay, wheat bran and ›d brewers' grains fed in the proportion indicated in the ration.

—*a*. A second "home-grown" ration, composed of 16.4 pounds of nson clover hay and thirty pounds of corn silage, proved a practical from the feeder's standpoint, reducing the cost of milk 18.3 cents hundred when fed in comparison with a ration in which the protein largely purchased.

. The gain from feeding this "home-grown" ration over the feed on amounted to $1.10 per cow per month.

. On the basis of this experiment, when wheat bran costs $26 per , dried brewers' grains $20 per ton and mixed hay (timothy and top) $16 per ton, and when these feeds are used in the proportion icated in the ration, crimson clover hay is worth $16.55 per ton as ıbstitute for the above foods.

—*a*. A third "home-grown" ration, composed of thirty-six pounds cow pea silage, ten pounds of crimson clover hay and six pounds n and cob meal, costing 16.57 cents, produced as much milk as a ion in which over two-thirds of the protein was purchased in the m of dried brewer's grains and cottonseed meal and which cost 15 cents.

. The results of this experiment are significant in showing that a ion composed of home-grown crops, though costing nearly as much hen the crops are figured at the market price), may be fully equal a milk producer to a ration in which the protein is largely supplied purchased feeds.

. Home-grown crops were utilized in the dairy at a greater profit ın could have been realized by selling them at the market price.

Soiling Crops, 1902.

The season of 1902 was characterized by an unusually cool temperature. Aside from this, it was particularly favorable to the growth of forage crops. With the exception of the month of May (precipitation 1.51 inches), the rainfall was well distributed throughout the growing season and no serious droughts occurred. Twelve kinds of forage were grown, alfalfa proving the most valuable on the basis of cost of production, yield and composition. The herd, including young stock, was equivalent to fifty full-grown animals. The arrangement of forage crops shown in Table I. furnished a continuous supply from May 1st until October 16th. About one and one-half tons of green forage were cut each morning to supply the herd for the day. This was fed to the cows in a two-acre field, into which they were turned every morning for exercise. The amount of forage fed varied according to the kind of fodder and the requirements of the animal. The average amount per day was sixty-one pounds per cow. In addition to the roughage used in summer, the cows received a feed ration averaging 7.2 pounds per cow per day, of wheat bran, dried grains, malt sprouts and corn meal or rice meal, mixed in proportion to make a ration having a nutritive ratio of about 1.6.

A careful record was kept of the cost of producing each crop, time of cutting and seeding and the yield per acre. Data concerning crops grown in 1902 are contained in the following table:

TABLE I.

Cost and Yield of Soiling Crops.

Number of acre.	KIND.	Date of seeding.	Seed used—bushels.	COST OF— Labor.	COST OF— Seed.	COST OF— Fertilizer.	Period of cutting and feeding.	Yield—tons.	Total cost.
2	Rye	Oct. 10, 1901	4	$3 10	$2 40	....	May 1- 4	4.20	$5 50
2	Rye	" 2, 1901	4	6 20	2 40	....	" 4-16	11.31	8 60
2	Wheat	" 9, 1901	4	5 40	3 20	....	" 16-26	10.60	8 60
1.87	Alfalfa (first cutting)	May 28, 1901	1	....	....	$5 18	" 26-31	6.61	5 18
1	Alfalfa (first cutting)	" 14, 1898	7/12	....	....	2 48	" 31 to June 6	7.36	2 48
2	Peas and Oats	Mar. 26	{ 2½ 4 }	6 00	6 00	5 54	June 6-14	12.04	17 54
2	Peas and Oats	April 14	{ 3 4 }	7 80	6 74	5 54	" 14-21	10.44	20 08
2	Peas and Oats	" 17	{ 3 4 }	4 50	6 74	5 54	" 21 to July 1	17.08	16 78
1.87	Alfalfa (second cutting)	....	....	....	....	....	July 1- 5	5.85	....
1	Alfalfa (second cutting)	....	....	....	....	....	" 5- 9	6.19	....
1	Mixed Grasses	....	....	....	....	....	" 9-14	6.70	....
5	Cow Peas	May 22	7½	14 40	16 88	12 50	" 14 to Aug. 6	42.80	43 78
1	Soy Beans and Sorghum (second crop)	June 4	{ 1 ½ }	3 30	2 50	2 77	Aug. 6-10	7.25	8 57
1	Cow Peas and Sorghum (second crop)	" 4	{ 1 ½ }	3 30	3 25	2 77	" 10-13	6.70	9 32
2	Barnyard Milllet (second crop)	" 16	1½	6 60	2 04	5 68	" 13-22	20.01	14 32
1	Cow Peas (second crop)	" 9	2	3 30	4 50	3 61	" 23-28	12.00	11 41

TABLE I.—Continued.

Cost and Yield of Soiling Crops.

Number of acre.	KIND.	Date of seeding.	Seed used—bushels.	COST OF— Labor.	Seed.	Fertilizer.	Period of cutting and feeding.	Yield—tons.	Total cost.
1	White Flint Corn	May 9	1/4	$4 20	$0 25	$2 77	Aug. 28 to Sept. 3	10.50	$7.22
1	White Flint Corn	June 18	1/3	5 25	33	2 30	Sept. 3–9	10.00	7 88
1	Corn (variety test, second crop)	" 18	1/3	4 50	33	4 55	" 9–20	14.14	9 38
2	White Flint Corn (second crop)	July 2	2/3	11 40	70	5 54	" 20 to Oct. 2	14.95	17 64
1	Southern White Corn	May 1	1/3	4 80	35	2 77	Oct. 2–9	11.00	7 92
1	Cow Peas	July 3	2	3 15	4 50	2 77	" 9–13	6.41	10 45
2	Barley (third crop)	Aug. 19	3	3 15	2 50	5 54	" 13–16	3.56	11 19
	Total							257.00	

General Remarks Concerning Crops.

Rye and Wheat.—The cutting of rye began the 1st of May this season. Four acres were grown for soiling. The yield ranged from 2.1 tons to 6.55 tons per acre. The light yields were due to the rye being cut early, in order to seed the land to other crops.

Wheat followed rye, two acres producing 10.6 tons.

Alfalfa.—The acre of alfalfa sown May 14th, 1898, was cut five times this season, the yield at each cutting being as follows: June 2d, 7.36 tons; July 5th, 6.19 tons; August 6th, .49 tons hay, equivalent to 1.96 tons green forage; September 9th, 4 tons; October 15th, .60 tons. The total yield for the year was 20.11 tons of green forage. The following table shows the yield of alfalfa from this field and the cost per acre for five years:

TABLE II.

The Yield of Alfalfa and the Cost per Acre for Five Years.

			Yield—tons.		Cost of—				
					Labor.				
	Seed—pounds.	Date of seeding.	Green forage.	Equivalent to hay.	Seeding.	Harvesting.	Seed.	Manures and fertilizers.	Total cost.
First year	30	May 14, 1898.	8.00	2.00	$3 65	*$1 92	$3 15	$23 65	$32 37
Second year	....	....	20.21	5.05	....	4 86	....	20 83	25 69
Third year	....	....	26.60	6.65	....	6 39	....	18 15	24 54
Fourth year	....	....	21.70	5.43	....	5 21	....	17 75	22 96
Fifth year	....	....	20.11	5.03	....	4 83	....	17 48	22 31
Total	30	....	96.62	24.16	$3 65	$23 21	$3 15	$97 86	$132 87
Average	....	....	19.32	4.83	....	4 64	....	19 57	26 57

* On hay basis.

Another field of alfalfa, consisting of 1.87 acres, was seeded in the spring of 1901. This plot yielded this season (1902) at the rate of 12.5 tons of green forage per acre.

Disking Alfalfa.

By disking alfalfa is meant the going over it in the spring, before growth starts, or in the summer, immediately after cutting, with a disk harrow. It is customary to set the disks at a slight angle. This cuts the crown roots and stirs the soil. Both our old alfalfa field and the one seeded last year were disked in August, this season, immediately after cutting the crop. The disking appeared to be beneficial to both fields, as it was followed by a vigorous growth and a general branching of the crown roots. Seed was sown where the alfalfa was thin, which, while it sprouted, was soon shaded and choked out by the growth of the old plants, except where the ground was nearly bare.

Crimson Clover.—This plant, which for six years has proved valuable in the forage rotation, was almost completely destroyed by the severe weather last winter.

Peas and Oats.—This season was particularly favorable for the growth of peas and oats. No serious drought occurred after the crop was well started, and the peas, as well as the oats, made a vigorous growth, especially those which were seeded about the middle of April. Six acres were grown, the yields ranging from 5.2 to 9 tons per acre.

Cow Peas.—The cow pea continues to be a valuable forage. It grows best on land that is free from weeds and, with a normal amount of rainfall, it is a sure crop. Seven acres were grown this year. The yields ranged from 6.41 to 12 tons per acre and averaged 8.74 tons.

Soy Beans.—A crop similar to the cow pea, but which does not yield quite as heavily. One acre was grown this season and the crop put in the silo, to be used in a feeding experiment.

Barnyard Millet.—A very desirable variety of forage, as it yields heavily and retains its palatability up to the time of blooming. It also has the characteristic of growing very rapidly, thus making a valuable crop for short rotations. Good yields have been secured at the College Farm in forty-five days. One acre treated with 160 pounds of nitrate of soda this season yielded 13.38 tons.

Corn.—A test was made with several varieties this season to study their value for forage. Two samples, designated in the test as "Ohio Yellow" and "Ohio White," were sent to the Station from that State; the variety "Parker's Mammoth Yellow" was secured from Illinois; the "Southern White" variety was obtained from Virginia; the "Mon-

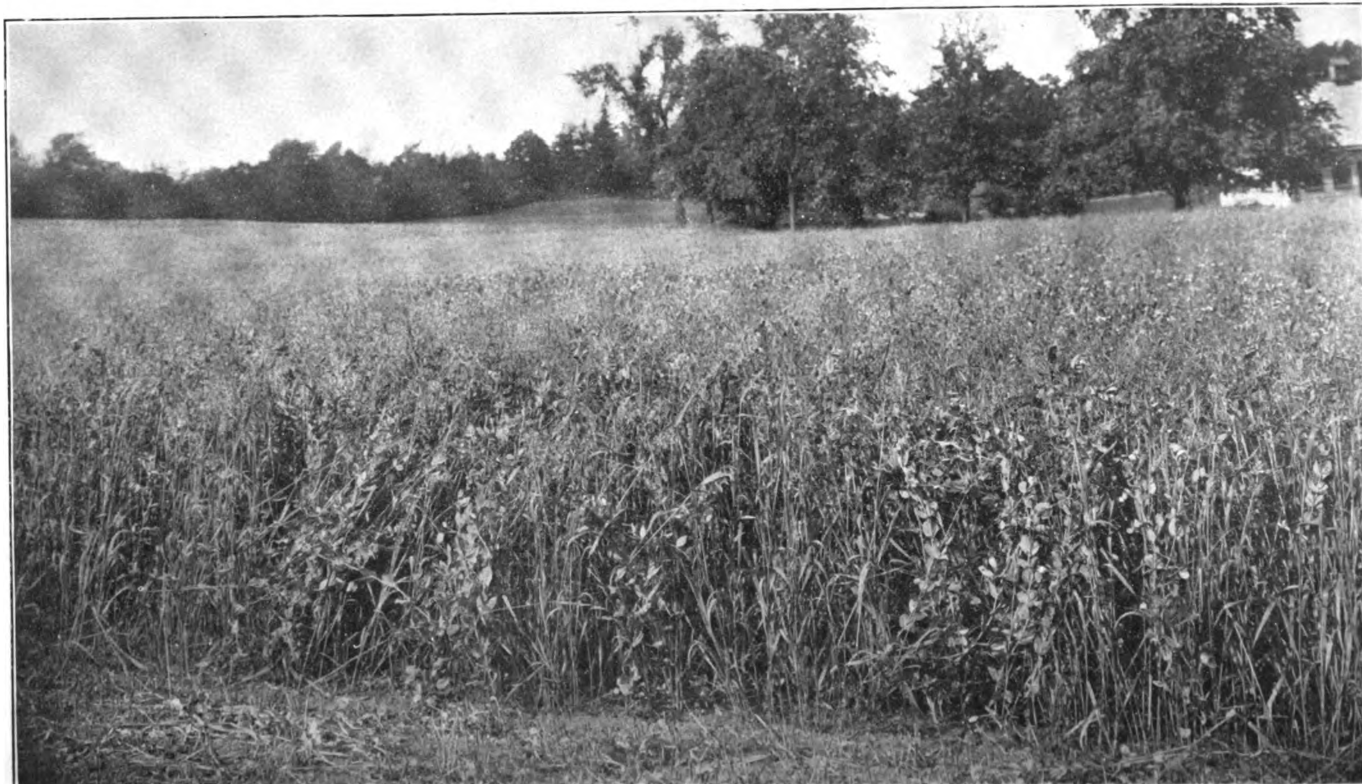


Fig. 1.

Fig. 9

mouth White" is a common variety in Monmouth county, this State, while the "Leaming" and "White Flint" have been grown on the College Farm for some years, and the seed used was taken from our own crop. The corn was planted June 18th in drills three and one-half feet apart and at the rate of ten quarts of seed per acre. One twenty-second of an acre was given to each variety. The yields are shown in the following table:

Yields of Different Varieties of Corn.

Variety.	State from which Seed was Obtained.	Yield per Plot, Pounds.	Yield per Acre, Tons.
Monmouth White	New Jersey	1,480	16.28
White Flint	New Jersey	1,350	14.85
Ohio White	Ohio	1,350	14.85
Southern White	Virginia	1,200	13.20
Parker's Mammoth Yellow	Illinois	1,190	13.09
Leaming	New Jersey	1,125	12.38
Ohio Yellow	Ohio	950	10.45

It is noticeable that two New Jersey varieties are among the highest yielders, namely, "Monmouth White" and "White Flint," which produced at the rate of 16.28 and 14.85 tons per acre, respectively. The "Ohio White" yielded the same as the "White Flint," while the yield from the other varieties range from one and one-half to four tons less. The "White Flint" variety has been grown for forage at the College Farm for a number of years, with good results. Owing to its suckering habit, vigorous leafy growth and palatability, it is particularly well adapted for soiling. The "Ohio White," "Southern White" and "Parker's Mammoth Yellow" are coarser varieties and better adapted for the silo than for forage. The "Leaming," while not a heavy yielder for forage, is a very desirable variety for field corn.

Barley.—This is the latest forage fed in the fall. It has been our practice for the past three years to seed rye with barley in August or September and cut the barley the last of October. The rye holds over the winter and makes an early start in the spring. The plan has proven an excellent one, and four acres were treated in a similar way this season. To secure a good crop of barley it should be seeded as early as the first week in August.

Special Crops.

Soy Beans and Sorghum.—A combination of crops which has proved valuable in some localities. One acre was grown at the Station for the first time this year. Continued wet weather soon after seeding seemed to be unfavorable for the crop and growth was very slow. The acre yielded 7.25 tons.

Cow Peas and Sorghum.—A crop similar to the above. One acre was seeded at the same time and yielded 6.70 tons per acre. Further experiment is necessary to determine the value of both of these crops for forage.

Cow Peas and Corn as a Silage Crop.—A preliminary report on this combination of crops for the silo was given last year (1901). The statement was then made that the crop was cut with a corn harvester without any difficulty, and further, that the two crops passed readily through the silage cutter into the silo. Since the last report the silage from this crop has been fed to the dairy herd. It was in good condition and was much relished by all the animals.

Two acres of cow peas and corn were planted in a similar way this year, except that the cow peas were mixed with the corn and planted at the same time, while last year the peas were planted three weeks later. It is believed that a still better plan than either of these would be to plant the cow peas and corn the same date, but put them in separately—that is, with two operations. It was found that when the corn and peas were mixed before planting neither was distributed evenly. This is a very important part of the seeding.

Soiling Crop Rotations, 1902.

The arrangement of crops shown in Table III. furnished a continuous supply of forage for the dairy herd from May 1st until October 16th; the Dwarf Essex Rape on acres 1 and 2, the wheat on acres 3 and 4, and the rye on acres 5, 6, 15 and 17 to 22 were used for green manure. The total yield per acre for all crops in the year's rotation shows a profitable return. Leaving out of consideration the crops that were turned under, five acres yielded less than ten tons, ten acres yielded more than ten tons and less than fifteen, four yielded over fifteen and less than twenty, while two yielded over twenty tons. The average yield per acre for the crops in the year's rotation, not including those turned under, was 13.09 tons.

TABLE III.

Soiling Crops—Number, Kind and Acreage, 1902.

Number of acre.	CROP ROTATION.	Yield per acre.	NUTRIENTS.		
			Protein.	Ether extract.	Fiber and N free extract.
		Tons.			
1	* Dwarf Essex Rape	....	....	....	....
	Peas and Oats	6.02	638.12	79.46	1,241.98
	Barnyard Millet	7.63	245.69	134.29	3,254.23
	Total	13.65	883.81	213.75	4,496.21
2	* Dwarf Essex Rape	....	....	....	....
	Peas and Oats	6.02	638.12	79 46	1,241.98
	Barnyard Millet	13.38	430.84	135.49	5,689.13
	Total	19.40	1,068.96	214.95	6,931.11
3	* Wheat	....	....	....	....
	Peas and Oats	5.22	553.32	68.90	1,076.89
	White Flint Corn	7.80	257.40	96.72	2,581.02
	Total	13.02	810.72	165.62	3,657.91
4	* Wheat	....	....	....	....
	Peas and Oats	5.22	553.32	68.90	1,076.89
	White Flint Corn	7.15	235.95	88.66	2,565.94
	Total	12.37	789.27	157.56	3,642.83
5	* Rye	....	....	....	....
	Peas and Oats	8.08	856.48	106.66	1,666.90
	† Soy Beans	4.70	267.90	51.70	1,281.22
	Total	12.78	1,124.38	158.36	2,948.12
6	* Rye	....	....	....	....
	Peas and Oats	9.00	954.00	118.80	1,856.70
	Cow Peas	6.41	369.22	98.71	1,282.00
	Total	15.41	1,323.22	217.51	3,138.70
7	Wheat	7.50	416.25	135.00	2,682.00
	Soy Beans and Sorghum	7.25	304.23	76.85	1,840.05
	Barley	1.20	64.80	14.40	379.20
	Total	15.95	785.28	226.25	4,901.25
8	Wheat	4.64	257.52	83.52	1,659.26
	Cow Peas and Sorghum	6.70	248.08	85.76	1,457.25
	Barley	2.36	127.44	28.32	745.76
	Total	13.70	633.04	197.60	3,862.27
9	Rye	6.55	339.95	78.60	2,397.30
	Corn (variety test)	14.14	466.62	175.34	4,678.98
	Total	20.69	806.57	253.94	7,076.28
10	Rye	4.76	247.04	57.12	1,742.16
	Cow Peas	12.00	691.20	184.80	2,400.00
	Total	16.76	938.24	241.92	4,142.16

* Used for green manure.

† Put in silo.

TABLE III.—Continued.

Soiling Crops—Number, Kind and Acreage, 1902.

Number of acre.	CROP ROTATION.	Yield per acre.	NUTRIENTS.		
			Protein.	Ether extract.	Fiber and N. free extract.
		Tons.			
11	Orchard Grass	1.88	95.16	32.94	[illegible]
	White Flint Corn	10.00	330.00	124.00	[illegible]
	Total	11.88	425.16	156.94	[illegible]
12—	Alfalfa	18.00	1,080.30	280.10	[illegible]
13—	Alfalfa	20.11	1,671.14	355.95	[illegible]
14—	Alfalfa	12.00	997.20	212.40	[illegible]
15	*Rye	....	....	....	....
	White Flint Corn	10.50	346.50	130.20	[illegible]
	Total	10.50	346.50	130.20	[illegible]
16	*Crimson Clover	....	....	....	....
	Southern White Corn	11.00	289.85	99.60	[illegible]
	Total	11.00	289.85	99.60	[illegible]
17-21	*Rye	....	....	....	....
	Cow Peas, (5 acres)	42.76	2,462.98	658.50	[illegible]
	Total	42.76	2,462.98	656.50	[illegible]
	Four tons clover hay contains		1,080	264	[illegible]
	Three " " " "		810	198	[illegible]
	Two " " " "		540	132	[illegible]
	Three tons wheat bran contains		924	246	[illegible]
	Three tons corn meal "		558	228	[illegible]

* Used for green manure.

A comparison of the amount of nutrients obtained per acre from the various combinations of crops, with that contained in clover hay, will give a better idea of their feeding value. For example, on acre No. 13 (alfalfa) the protein is equivalent to that contained in 6.2 tons of clover hay or 5.4 tons of wheat bran. On acres 5, 6 and 12 it is equivalent to that in more than four tons of clover hay; in 1, 2, 3, 10 and 14 to more than three tons; on 4, 7, 8 and 9 to over two tons and on the remaining eight acres to an average of 1.14 tons.

In nearly every case, the proportion of carbohydrates exceeds the proportion contained in clover hay, thus making the nutrients comparable with this crop. The nutrients contained in three tons of

wheat bran and corn meal, respectively, are also added in the table for comparison.

In eight acres, three crops are grown upon an acre in a year, but, with the exception of plots 7 and 8, the yield from only two crops is included, as the third crop was turned under. On ten acres two crops were grown, and in seven of these cases the first crop was turned under. On the remaining three acres only one kind of crop was grown. The actual yields, therefore, from thirteen of the twenty-one acres was larger than is indicated.

Practical Rotations for Soiling.

This line of work, which has now been in progress seven years, has proved valuable in showing the possibilities of intensive farm practice under good average conditions. Table IV. gives some rotations which have proved practical in respect to amount of nutrients as well as tonnage of green forage per acre. In many cases it has been possible to obtain as many as three crops per year of the regular summer forage crops, and as many as five cuts per acre of such perennials as alfalfa.

TABLE IV.

Some Practical Forage Rotations—Annual Yield Per Acre.

No. of acre.	Crops in one-year rotation.	Time of seeding.	Time of cutting.	Yield per acre. Tons.
1	Rye and Crimson Clover	September	May 1-10	8.05
	Oats and Peas	May 10	July 1-10	7.60
	Soy Beans	July 10	Sept. 1-10	9.00
	Total			24.65
2	Wheat Fodder	September	May 10-20	7.00
	Cow Peas	May 20	July 10-20	8.20
	Japanese Millet	July 20	Sept. 10-20	7.00
	Total			22.20
3	Oats and Peas	April 1	June 10-20	7.34
	Japanese Millet	June 20	Aug. 1-10	8.73
	Barley and Peas	Aug. 10	Oct. 10-20	6 03
	Total			22.10

No. of acre.	Crop in one-year rotation.	Time of seeding.	Time of cutting.	Yield per acre. Tons.
4	Oats and Peas	April 10	June 1-10	6.80
	Cow Peas	June 10	Aug 10-20	8.20
	Barley and Peas	Aug. 20	Oct. 20-30	6.30
	Total			21.30
5	Rye	September	May 1-7	9.60
	Cow Peas	June 10	Aug. 25-Sept. 1	10.50
	Barley	Sept. 2	Oct. 27-Nov. 1	2.60
	Total			22.70
6	Rye	October	May 7-19	9.60
	Soy Beans	June 10	Aug. 19-25	8.80
	Barley	Sept. 2	Oct. 27-Nov. 1	2.60
	Total			21.00
7	Crimson Clover	July	May 20-June 1	8.00
	Corn	June 1	July 20-Aug. 1	9.56
	Total			17.56
8	Mixed Grasses	September	June 20-30	7.00
	Corn	June 20	Aug. 20-Sept. 1	12.34
	Total			19.34
9	Rye and Vetch	Sept. 10	May 10-19	8.60
	Corn	May 27	July 20-29	11.80
	Total			20.40
10	Rye	August	May 1-10	8.50
	Pearl Millet	May 18	Aug. 8-15	15.10
	Total			23.60
11	Oats and Peas	Aug. 10	June 16-23	10.30
	Cow Peas	Aug. 1	Sept. 16-22	8.60
	Total			18.90
12	Oats and Peas	Aug. 21	June 29-July 6	10.50
	Flint Corn	July 10	Sept. 22-30	11.00
	Total			21.50
13	Oats and Peas	April 2	June 26-July 4	6.10
	Cow Peas and Kaffir Corn	July 10	Sept. 1-16	12.30
	Total			18.40
14	Alfalfa—First year, two cuttings			8.00
	" Second year, four cuttings			20.21
	" Third year, five cuttings			26.60
	" Fourth year, four cuttings			21.70
	" Fifth year, five cuttings			20.11

What Constitutes Value in a Forage?

(1) YIELD AND COMPOSITION.

In the case of fine feeds the amount and quality of the nutrients they contain are taken as the basis in making a comparison of their feeding value. This method is also applicable in comparing the value of forage crops for milk production. The number of tons produced of any forage is not, in itself, a safe guide as to its value. For example, corn, at that stage of maturity which would make it a useful crop for feeding green, will contain about 25 per cent. of dry matter, whereas, certain millets, Kaffir corn, etc., belonging to the same group of plants, will oftentimes contain as little as 10 per cent. The same is true in the case of the leguminous crops; certain of these are much more watery at the proper stage for feeding than others. This point of variation of dry matter in the different crops should be taken into consideration, together with the other important one, namely, the influence of the proportion of the different nutrients in determining their value. For example, those crops which belong to the cereal group—corn, millet, sorghum, etc.—are carbonaceous in their character, and should be fed in connection with leguminous crops, which supply a larger amount of protein.

(2) SEASON OF THE YEAR IN WHICH THE CROP MAY BE GROWN AND TIME REQUIRED FOR IT TO MATURE.

There are certain winter annual plants, as rye, wheat and crimson clover, which are very valuable in the forage rotation from the fact that they are available in the early spring. Again, there are other crops which grow best, and can only be grown, in early or midsummer; among these may be mentioned oats and peas, cow peas and soy beans. Then there are others that are valuable for the reason that they will make considerable growth after the weather becomes cool, as barley, corn and certain of the grasses.

Other plants are valuable from the fact that they will mature in a very short period. In this class are included the various millets, the barnyard variety producing a crop in from forty to fifty days. The number of plants that will supply forage through the entire growing

season is very limited. Alfalfa comes as near to this as any we have had experience with. Cuttings from this crop have been made as early as May 12th and as late as October 22d.

(3) PALATABILITY AND INFLUENCE UPON THE FLAVOR OF MILK.

A plant that is not palatable is of but little value for forage. Fortunately there are not many that belong to this class. The following are not readily eaten by dairy stock: Yellow and Rural Branching Doura (Millo Maize) and Evergreen Broomcorn. Animals sometimes refuse to eat certain varieties of peas and beans for a short period, but they soon learn to like them. There is no forage crop which we have tested, with the exception of Dwarf Essex Rape, that has given an unpleasant flavor to milk when fed judiciously. This crop is not safe to feed to dairy cows. There is the most danger of producing a "grassy" flavor in milk at the beginning of the season, when animals are changed from dry foods to green forage. It sometimes occurs, also, when immature forage is fed. This undesirable effect can usually be overcome by feeding in limited quantities and always after milking.

Forage vs. Silage.

Inasmuch as the roughage in the rations for the dairy herd was composed largely of soiling crops from May 1st until November 1st, and of silage for the remaining six months, an opportunity is given for comparing the results from the two systems. Table V. shows the average yield of milk and the amount and percentage of butter fat produced by the herd for the past six years. Only those animals are included in this record which remained in the herd during the entire year.

The tabulation shows the average yield of milk per cow during the soiling and silage periods to be 3,457 pounds and 3,050 pounds, respectively, a difference of 407 pounds in favor of soiling. The average yield of butter was 173.8 pounds for the soiling period and 156 for the silage period, a difference of 17.8 pounds, also, in favor of soiling. The average percentage of fat for the two periods was practically the same, namely, 4.31 and 4.38. The number of fresh cows each month during the year was quite uniform, hence the comparison

TABLE V.

Summary Record of the Dairy Herd, Showing Average Yields of Milk and Fat During the Soiling and Silage Periods.

YEAR.	Number of cows.	SOILING PERIOD. MAY 1ST—NOVEMBER 1ST. Average yield per cow of—				SILAGE PERIOD. NOVEMBER 1ST—MAY 1ST. Average yield per cow of—			
		Milk.	Fat.	Butter.	Fat.	Milk.	Fat.	Butter.	Fat.
		lbs.	lbs.	lbs.	%	lbs.	lbs.	lbs.	%
1897	21	3,414	144.5	168.6	4.23	2,941	123.1	143.6	4.18
1898	20	3,174	140.7	164.2	4.43	2,970	132.0	154.0	4.44
1899	12	3,889	164.3	191.7	4.23	3,078	137.8	160.8	4.48
1900	27	3,390	153.4	179.0	4.53	2,975	137.2	160.1	4.61
1901	26	3,250	137.1	160.0	4.22	3,287	144.2	168.2	4.39
1902	30	3,624	153.8	179.4	4.24	3,046	127.7	149.0	4.19
Average	22⅔	3,457	149.0	173.8	4.31	3,050	133.7	156.0	4.38

of yields for the two systems is a fair one, and shows that both systems are practicable in respect to the quantity, as well as the quality of the product produced.

Experiments with Nitrate of Soda on Rye, Wheat, Barnyard Millet and Barley.

Two acres were included in the experiment with each crop, one being treated with nitrate of soda as a top dressing, while the other, untreated, served in making the comparison. The objects of the experiment were (1) to study the effect of nitrate of soda upon the yield of the crop, and (2) to determine whether its use on forage crops was practicable from a financial standpoint. The following table shows the date and the amount of the application on the different crops and the yield from the treated and untreated plots.

TABLE VI.

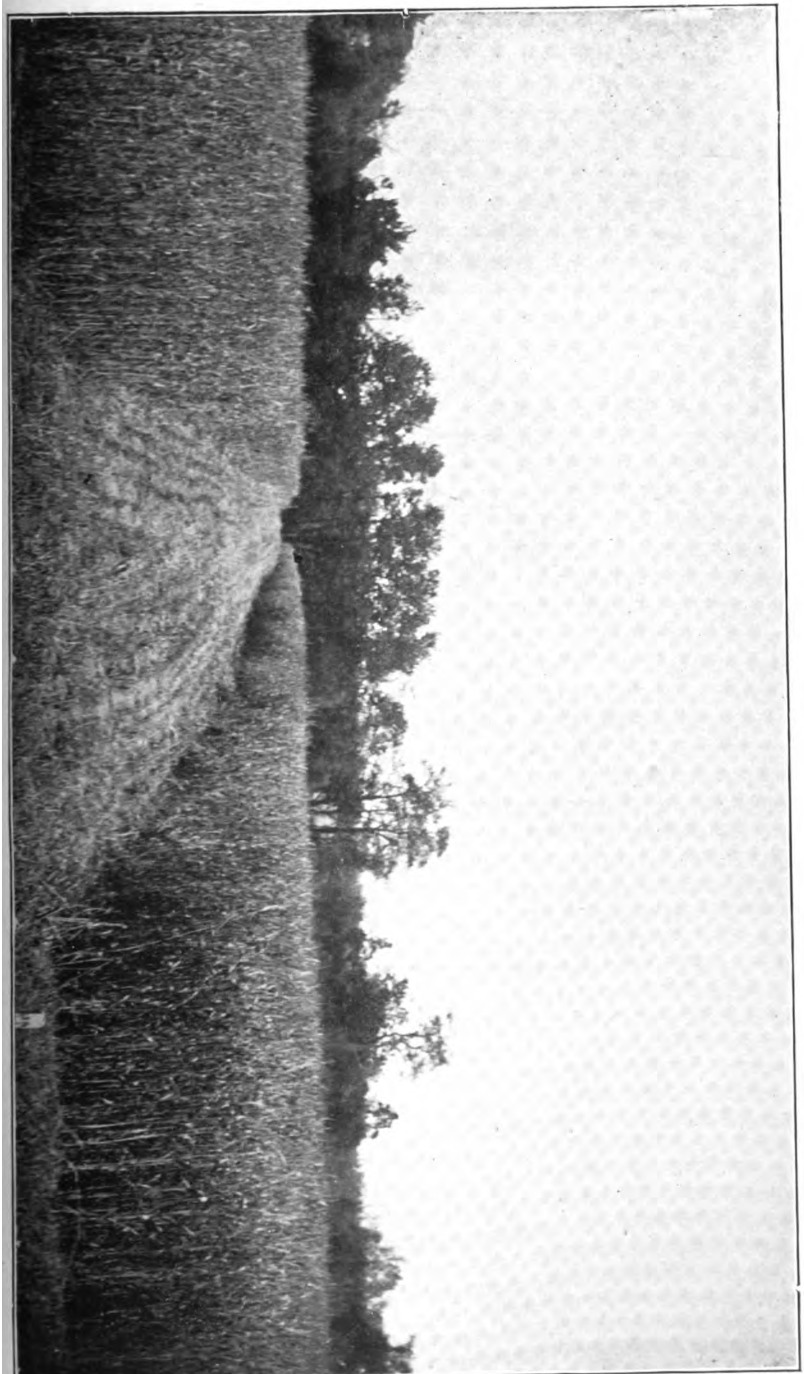
KIND.	Date of application.	Amount of nitrate applied.	Date of cutting.	YIELD.		GAIN.			Cost of nitrate per acre.	Net gain over cost.
				Untreated acre.	Treated acre.	Tons.	Per cent.	Value at $3 per ton.		
		lbs.		Tons.	Tons.					
Rye	April 1.	150	May 4–16.	4.76	6.55	1.79	37.6	$5 37	$3 38	$1 99
Wheat	" 1.	150	" 16–26.	4.64	7.50	2.86	61.6	8 58	3 38	5 20
Barnyard Millet	July 10.	160	Aug. 18–22.	7.63	13.38	5.75	75.4	17 25	3 60	13 65
Barley	Sept. 12.	160	Oct. 13–16.	1.20	2.36	1.16	96.6	3 48	3 60	— 12

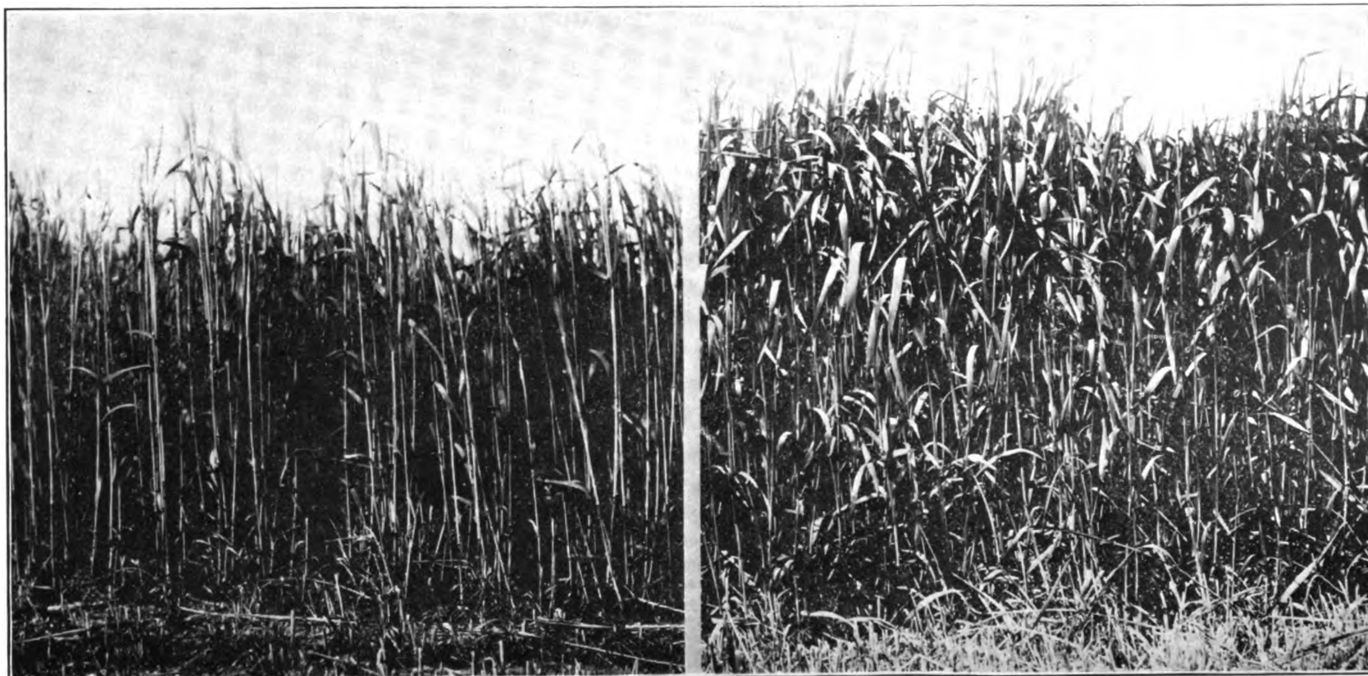
The tabulation shows that the amount of nitrate applied on the different plots ranged from 150 to 160 pounds per acre. The gain in yield ranged from 1.16 tons, in case of the barley, to 5.75 tons for the barnyard millet. The percentage of gain ranged from 37.6 on the rye to 96.6 on the barley. The financial gain, which is the most important consideration, ranged from —12 cents on barley to $13.65 on millet. It should be stated, in connection with the experiment with barley, that the test was made very late in the season, when the growth was slow. It is reasonable to suppose that only a part of the nitrate applied was taken up by the crop, which yielded only 2.36 tons per acre, although this amount was nearly double that obtained from the untreated plot.

The results indicate that crops of this nature may be very materially increased by applications of nitrate of soda at the rate of 150 to 160 pounds per acre. They also show that the treatment is profitable from a financial standpoint, especially early in the season, when forage is not abundant.

Experiments with Lime on Cow Peas, Soy Beans and Forage Corn.

The object of these experiments was principally to study the effect of lime upon the yield of various forage crops, particularly where they had been grown continuously for a number of years without applications of lime. One acre was included in each experiment, one-half of which was treated with Corson's Prepared Lime, while the other half remained untreated. The following table gives the date and amount of the applications of lime and the yields from each plot:





Untreated plot. **Fig. 4.** Treated plot.

Experiment with Nitrate of Soda on Wheat.

Treated plot. **Fig. 5.** Untreated plot

Experiment with Nitrate of Soda on Barnyard Millet.

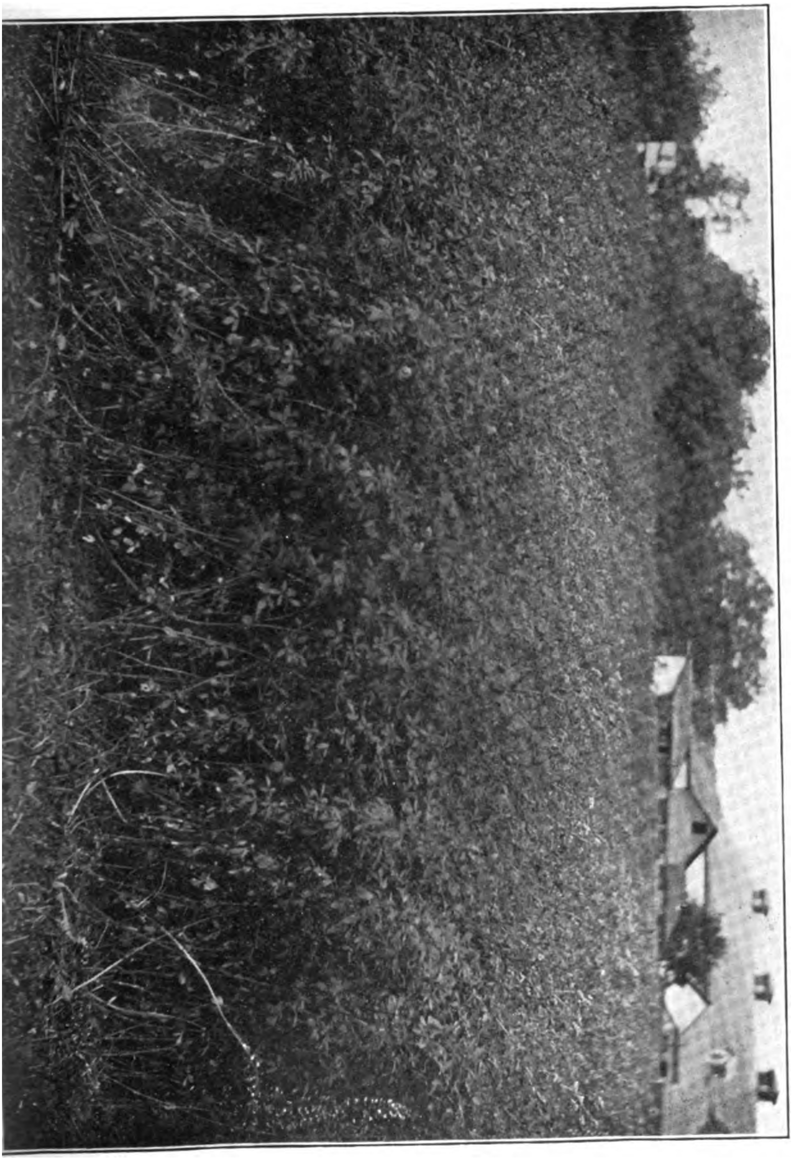


TABLE VII.

	Acres.	Date of application.	Corson's prepared lime.	Date of harvesting.	Yield per acre		Gain.	
					Untreated plot.	Treated plot.	Pounds.	Per cent.
			lbs.		lbs.	lbs.		
Cow Peas	1/3	July 3.	300	Oct. 9-12.	12,000	13,640	1,640	13.66
Soy Beans	1/3	" 3.	300	" 7.	8,800	10,000	1,200	13.64
Forage Corn	1/3	" 10.	300	Sept. 27—Oct. 3.	14,880	16,360	1,480	9.95

The tabulation shows a gain from the application of lime on all of the crops. The greatest increase was obtained on the cow peas and soy beans, which amounted to 13.66 and 13.64 per cent., respectively. The gain on the forage corn amounted to 9.95 per cent. In all cases the crops followed oats and peas, which yielded at the rate of 7.43 tons per acre. Hence, while the yields given in the above table are not large, the total yields from the two crops show profitable returns.

Cover Crops.

In addition to rye, wheat and crimson clover, which have been used at the Station as cover crops for a number of years, some new kinds were given a trial this year.

Crimson Clover and Cow-Horn Turnips.—This combination of crops has proven valuable elsewhere and was given a trial here this season. Two acres were seeded in corn August 2d, 1901 (at the time of last cultivation), at the rate of eleven pounds of crimson clover and two ounces of Cow-horn turnips per acre. The seed of both crops sprouted immediately and made a vigorous growth before frost. The Cow-horn turnip has the characteristic of penetrating deeply into the soil, hence it utilizes food which cannot be reached by shallow-feeding plants. Figure 8 shows the crop November 1st. The turnips, as well as the clover, had made considerable growth, and the crops at this time were more than sufficient to pay for the seed and labor involved. The clover did not withstand the winter. Corn was planted the following spring, and there was a noticeable difference between these two

acres and the plots adjoining, which were sown to clover only, the cover of turnips and clover combined producing corn richer and greener in color and a better yield.

Dwarf Essex Rape.—A crop not commonly used for cover, but which possesses some advantages over other crops. Its many prongs and long rootlets penetrate the soil in all directions, hence it is a gross feeder and draws heavily on the soil. The varieties of rape that are really valuable for forage or cover do not mature seed the same year that they are sown. Of these the Dwarf Essex variety is probably the best—in fact, it is about the only kind which has been thought worthy of cultivation in this country. Two acres of this variety were sown September 11th, 1901, after a crop of cow peas and Kaffir corn. The seed sprouted quickly and continued to grow until severe cold weather. As this crop has a different root system from cover crops commonly grown, it is believed to be a desirable practice to use it occasionally as a cover crop or in the forage rotation, to aid in gathering from the soil plant food which might not otherwise be utilized.

Cost of Producing Milk.

Beginning April 1st, 1896, records have been kept of the cost of labor, the kind, amount and cost of foods eaten by the dairy herd and the amount of milk produced by each cow. The cost of producing milk in previous years has been published in the annual reports. The cost for the year ending April 1st, 1902, is here reported. The herd averaged thirty cows.

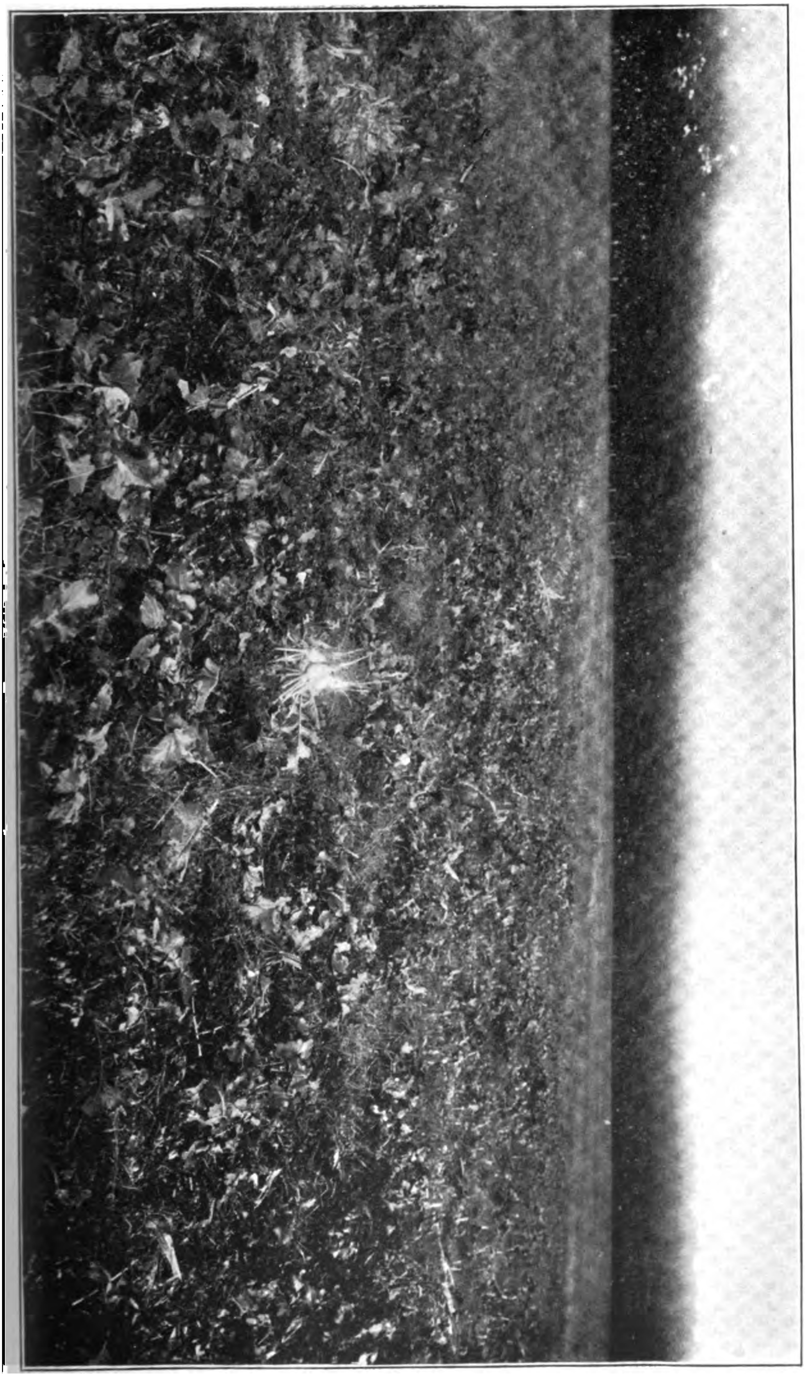


TABLE VIII.

Kind, Amount and Cost of Foods for Thirty Cows for One Year, April 1st, 1901, to April 1st, 1902.

	Amount Fed. lbs.	Cost per Ton.	Total.	
Wheat bran	24,000	$19 90	$238 80	
Dried grains	24,000	18 50	222 00	
Malt sprouts	3,000	20 20	30 30	
Buckwheat middlings	4,000	17 20	34 40	
Linseed meal	2,000	34 00	34 00	
Cottonseed meal	6,000	30 00	90 00	
Rice meal	4,800	20 45	49 08	
Corn meal	12,000	22 65	135 90	
Cost of feeds				$834 48
Soiling crops	314,000	1 60	251 20	
Silage	204,000	2 40	244 80	
Dried cornstalks	13,200	4 00	26 40	
Hay	21,600	5 00	54 00	
Roughage				$576 40
Total cost of food				1,410 88

Total cost of food	$1,410 88	
Cost per cow per day		12.88 cents.
Cost of feeds	834 48	
Cost per cow per day		7.62 cents.
Cost of roughage	576 40	
Cost per cow per day		5.26 cents.
Total yield of milk		87,754 quarts.
Average per cow per day		8.01 "
Cost of food per quart		1.61 cents.
Cost of feed per quart		.95 "
Cost of roughage per quart		.66 "

The cost of feeds represents what was actually paid. The cost of r, cornstalks and soiling crops represents the actual cost of labor, d, manures and fertilizers, the farm manure being charged at the e of $1.50 per ton. Fifteen of the twenty-two forage acres received lressing of manure at the rate of seven tons per acre.

The average cost of the dairy ration was 12.88 cents, of which 7.62 its, or 59.2 per cent., is due to purchased feeds and 5.26 cents, or 8 per cent., to the cost of farm crops. The total cost of producing lk, including the cost of labor and the interest on, and decrease in, value of the herd, are given, the latter item being estimated.

TOTAL COST OF PRODUCING MILK.

Foods as per statement		$1,410 88
Labor	$600 00	
Interest on value herd at 5 per cent	60 00	
Decrease on value herd at 5 per cent	60 00	
		$720 00
Total		$2,130 88
Cost of food per quart of milk		1.61 cts.
Cost of labor and interest per quart of milk		.82 "
Total cost per quart		2.43 "

The average weight per quart of milk, as put up in bottles for delivery, was 2.18 pounds; hence, the total weight of milk, 191,304 pounds, was equivalent to 87,754 quarts. The cost per hundred was, therefore, $1.11. At $1 per hundred, the price received in rural districts, the profits from the business, if any, must be in the manure. In the calculation of the cost of farm foods the manure was charged at the rate of $1.50 per ton. The amount produced by the herd during the year was 330 tons. In selling milk at $1 per hundred the receipts are $217.84 less than the expenses. Deducting this amount from the actual charges made for manure, in the growing of the crops—$1.50 per ton—there remains $277.16, which represents the profits from thirty cows, an amount too small to make the business pay. In rural districts, however, where pasture is abundant, the cost of food would not be as great as where soiling crops supply the entire ration, with the exception of concentrates.

At 3½ cents per quart, the price that could have been received at wholesale, the receipts would have amounted to $3,071.39. Deducting the cost of purchased feeds, labor and interest and decreases in the value of the herd, amounting to $1,554.48, we have a balance of $1,516.91, which represents the value of the home-grown product; or, in other words, at 3½ cents per quart for milk the farm would sell its produce to the dairy at profitable prices, namely, $4.21 for soiling crops, $6.32 for silage, $13.16 for hay and $10.53 per ton for dried corn stover, a gain on the crops over cost of production of $261 per ton for soiling crops, $3.92 for silage, $8.16 for hay and $6.53 for dried corn stover, besides an additional gain represented by 330 tons of manure.

Looking at the question of profit from another standpoint, we will assume that the dairyman performs the work himself. Deducting, therefore, the item of labor, which amounted to $600, from the total

of production ($2,130.88), we have a balance of $1,530.88. Di- ng this amount by the total pounds of milk produced (191,304), find the cost per hundred to be 80 cents. The difference, there- , between the cost and selling price of the milk represents the yman's profits when he performs the work himself.

ssuming that the milk produced by the above thirty cows had 1 sold for $1 per hundred, a profit of 20 cents would have been ized from every hundred pounds, or a total of $382.61 for the 's production, besides the additional gain represented by the 330 of manure. At 3½ cents per quart the profits would have unted to $1,541.51, besides the additional gain from the manure.

TABLE IX.

Average Cost of Producing Milk for Six Years.

YEAR.	Number of cows.	MILK PRODUCED. Pounds.	MILK PRODUCED. Quarts.	Average yield per cow.	COST PER COW PER DAY. Feeds.	COST PER COW PER DAY. Roughage.	COST PER COW PER DAY. Total.	COST PER QUART OF MILK OF— Feeds.	COST PER QUART OF MILK OF— Roughage.	COST PER QUART OF MILK OF— Labor and interest.	COST PER QUART OF MILK OF— Total.
				lbs.	cts.	cts.	cts.	cts.	cts.	cts	cts.
....	23	141,517	64,916	6,158	4.99	6.61	11.60	.646	.855	.99	2.49
....	25	154,768	70,990	6,191	5.06	6.38	11.44	.650	.820	.92	2.39
....	25	172,726	79,232	6,911	6.53	6.16	12.69	.750	.710	.82	2.28
....	30	198,345	90,984	6,612	6.65	6.58	13.23	.800	.790	.79	2.38
....	30	195,875	89,851	6,529	7.30	5.35	12.65	.890	.650	.80	2.34
....	30	191,304	87,754	6,377	7.62	5.26	12.88	.950	.660	.82	2.43
Average..........	......	175,756	80,621	6,462	6.36	6.06	12.42	.781	.748	.86	2.39

'he average production per year for the six years is shown to be ,756 pounds, equivalent to 80,621 quarts. The average yield per was 6,462 pounds. The average cost of food per cow per day 12.42 cents, of which 6.36 cents, or 51.2 per cent., was due to chased feeds, and 6.06 cents, or 48.8 per cent., to the cost of farm s. The average cost per quart of milk for the six years, includ- food, labor and interest and decrease in the value of the herd, is wn to be 2.39 cents.

The Dairy Business in Relation to Soil Exhaustion.

The following table shows the amount of fertilizing elements contained in the feeds purchased and in the milk produced by a herd of twenty-three cows in 1896, twenty-five cows in the years 1897 and 1898 and thirty cows in 1899, 1900 and 1901.

The above table shows a decided gain to the farm in fertility elements during all six years. The total gain is equivalent in nitrogen and phosphoric acid to that contained, respectively, in twenty-three tons of nitrate of soda and twenty-five tons of acid phosphate, and in potash to that contained in 2.18 tons of high-grade muriate of potash. It is not affirmed that the constituents contained in the manure are equal in agricultural value to those contained in the fertilizers mentioned, or that, even under the best conditions of care and application, they could all be used by the plants, but, because the manure contains all the constituents and is well adapted for most crops, the general farmer is, as a rule, able to get as good returns from it, in proportion to constituents contained, as from products containing the same constituents in more available forms.

The tabulation shows that if all the milk sold from the farm was obtained from foods grown on the farm, the exhaustion of nitrogen would be in greater proportion than the mineral elements, and that, when this is the practice, it is necessary to apply nitrogenous fertilizers in order to maintain the fertliity. If manure is well cared for and used properly, it is more economical to purchase the nitrogen in the form of feeding stuffs, whose whole cost is returned in the increased product resulting from the use of well-balanced rations.

TABLE X.

KINDS.	AMOUNT.						NITROGEN.						PHOSPHORIC ACID.						POTASH.					
	1896.	1897.	1898.	1899.	1900.	1901.	1896.	1897.	1898.	1899.	1900.	1901.	1896.	1897.	1898.	1899.	1900.	1901.	1896.	1897.	1898.	1899.	1900.	1901.
	tons.	tons.	tons.	tons.	tons.	tons.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs	lbs	lbs.	lbs.	lbs.	lbs	lbs	lbs.	lbs.	lbs.	lbs	lbs.
Wheat Bran	9.40	12.50	14.50	15.85	17.00	12.00	460	612	710	777	888	588	545	725	541	919	986	691	801	402	464	507	544	891
Dried Brewers' Grains	9.20	8.15	10.25	18.75	18.05	12.00	662	587	888	990	940	864	202	179	226	808	287	264	15	18	17	22	21	19
Corn Meal	6.10	8.80	5.00	7.05	7.50	6.00	201	109	165	288	248	198	85	46	70	99	105	84	49	26	40	56	60	48
Linseed Meal	8.55	4.45	8.50	1.05	.90	1.00	877	478	872	111	95	107	126	158	124	88	82	88	97	121	96	29	24	28
Malt Sprouts	......	......	......	......	......	1.50	......	......	......	......	......	124	......	......	......	......	......	49	......	......	......	......	......	56
Cottonseed Meal	......	......	......	1.75	4.50	8.00	......	......	......	288	612	406	......	......	......	106	275	185	......	......	......	66	171	114
Rice Meal	......	......	1.75	2.70	......	2.40	......	......	69	105	......	94	......	......	94	145	......	129	......	......	25	89	......	85
Pea Meal	......	......	......	......	1.00	......	......	......	......	......	82	......	......	......	......	......	16	......	......	......	......	......	20	......
Buckwheat Feed	......	......	.50	1.60	......	2.00	......	......	86	29	......	179	......	......	18	58	......	88	......	......	18	42	......	46
Total or gain in feeds	......	......	......	......	......	......	1700	1781	2190	2488	2760	2560	958	1108	1878	1668	1701	1528	462	562	655	761	840	787
Sold in Milk	70.86	77.88	86.86	99.17	97.94	95.65	849	927	1086	1190	1178	1146	818	847	889	446	440	429	248	271	802	847	848	885
Gain to Farm	......	......	......	......	......	......	851	854	1154	1298	1587	1414	640	761	984	1222	1261	1099	214	291	858	424	497	402
Total gain in six years	......	......	......	......	......	......	7,158						5,967						2,181					

Experiences with Parturient Paresis (Milk Fever).

The remarkable results obtained by the use of the Schmidt treatment for milk fever have led us to give our experience here. Inasmuch as the disease is well known to most dairymen, a detailed description of it is not essential. The necessary outfit for this treatment is not expensive. It requires a three-inch funnel, four or five feet of one-fourth inch rubber tubing and a small glass pipette or milking tube. The method of procedure which we have used is similar to that recommended by the Maryland Experiment Station in Bulletin No. 76, which is as follows:

(1) Dissolve 120 grains of iodide of potash in one quart of water which has been boiled and allowed to cool to about the temperature of the body.

(2) Introduce the funnel and pipette into the ends of the rubber tube and place in a bucket of antiseptic fluid.

(3) Milk the udder dry, then place under the cow a piece of oilcloth, about a yard square (a carriage storm-apron may be made to answer), so that the udder will be about the middle of the cloth. Wash the udder and teats thoroughly with castile soap and warm water, rinsing carefully with antiseptic fluid.

(4) Insert the pipette into the end of a teat and fill the funnel with iodide of potash solution. By passing successively from one teat to another, distribute the solution equally among the quarters of the udder.

(5) Rub the udder from the teat towards the body and massage thoroughly, in order to distribute the solution throughout.

(6) Eight or ten hours after the injection, or when recovery is assured, the udder should be carefully milked out and then bathed with warm water (about 160 degrees Fahrenheit).

A second injection is rarely necessary; but, if so, it should be done at the end of six or eight hours.

If there should be a tendency toward hardness of the udder or "stringiness" of the milk, baths of warm water should be applied every three or four hours until relieved. If neglected, Mastitis (Garget) will result.

Prevention.—As a preventive measure it is advisable to restrict robust animals to a moderate allowance of dry food for a week or ten days previous to the end of their term; and, where there is a tendency toward costiveness or constipation, correct it with a drench of Epsom salts.

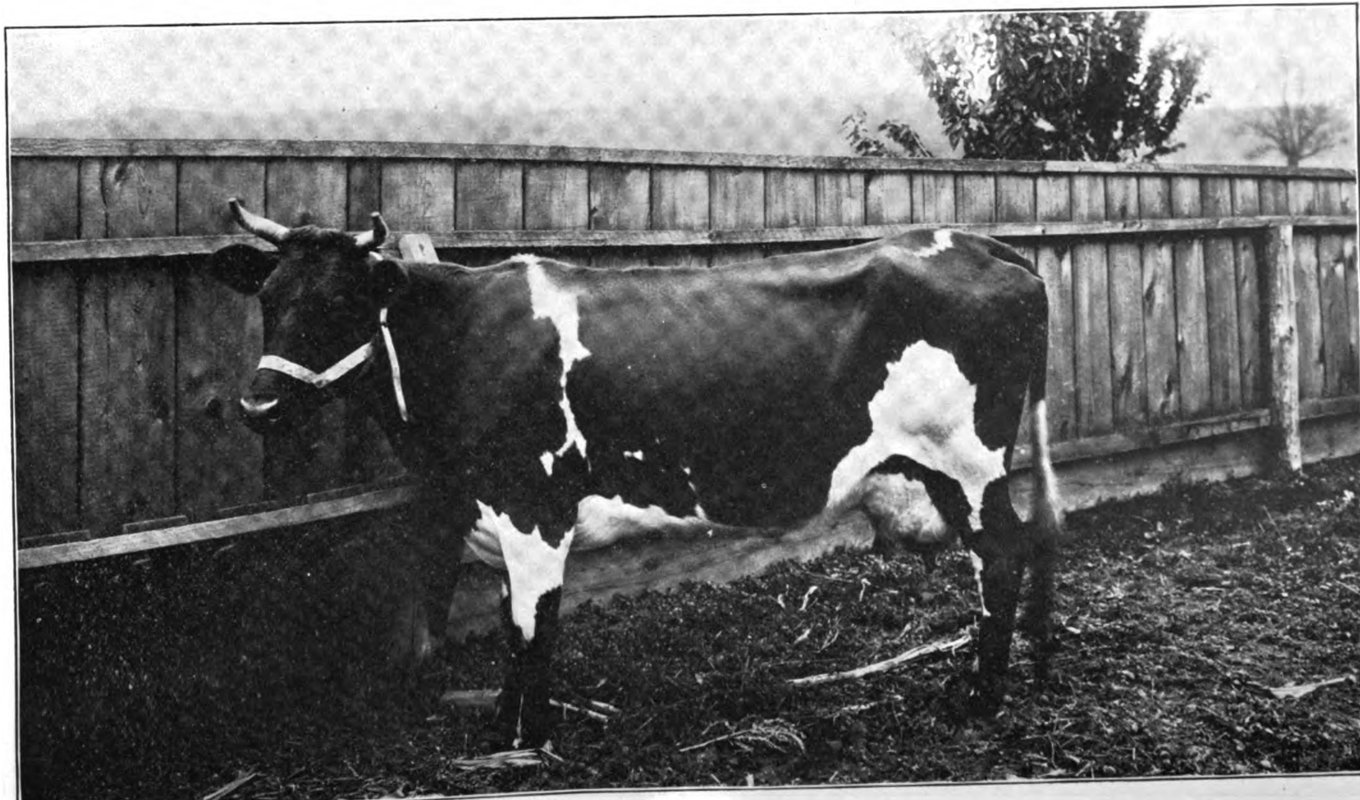


Fig. 8.

Zola—Cow Cured of Milk Fever by "Schmidt Treatment."

Fig. 9.
Filling the Silo

Formulæ for Solution.

Iodide of Potash Solution:

Iodide of Potash (crystals)	120 grains.
Water (previously boiled)	1 quart.

(When thoroughly dissolved inject into the udder as described).

Drench for Costiveness:

Epsom Salts	1 pound.
Ground Ginger	1 ounce.
Water (tepid)	3 pints.

(Give at one dose, administered slowly).

Antiseptic Solutions:

Creolin	1 part.
Water	30 parts.
Thymo-Cresol	1 part.
Water	30 parts.
Chloro-Naphtholeum	1 part.
Water	30 parts.

Any of these antiseptic solutions will answer for this treatment.

In four cases treated at the Station, as here indicated, three recovered. Of these one developed "stringiness" of milk, which was soon corrected.

Description of Milk Fever Cases.

Zola.—A cow five years old, calved on the afternoon of September 20th, and was given a drench immediately for costiveness, after which she appeared to be all right. Milk fever developed, however, on the morning of the 22d, and at seven o'clock the cow was down and unable to move. Iodide of potash was injected according to directions given above, and in one hour the animal showed signs of recovery, and at twelve o'clock, five hours after the treatment, she was standing up and eating. A little "stringiness" developed in the milk, which disappeared in a few days. A photograph of the cow is shown in Figure 9.

Princessa.—Six years old, calved May 22d, at noon. The following day she began to stagger about the stall and show signs of milk fever. In the course of an hour she became exhausted and lay prostrated in the stall, unable to raise her head. The Schmidt treatment was applied, and in fifteen minutes after the injection the cow was standing and a half hour later began to eat.

Cherry.—Calved January 1st and showed signs of milk fever the following day. The injection was made before the animal got down and recovery began immediately.

Woodlawn.—Calved May 15th and was taken with a severe attack of milk fever in the early morning of the 16th. This was well developed before discovered and complications set in in the form of digestive disturbances of the stomach and intestines, which caused constant bloating, although the trochar was used repeatedly. The Schmidt treatment was applied, but in spite of all efforts to relieve her, the animal died at six o'clock. The cow was old, which perhaps accounts for the disease being fatal in this case, as records show more fatalities among older animals.

RECORDS OF THE DAIRY HERD, APRIL 1ST, 1901, TO APRIL 1ST, 1902.

Beginning April 1st, 1896, complete records have been kept of the dairy herd, including the yield and composition of the milk of individual animals. These records have been published annually in the Station Reports.

The herd consists largely of grade animals—one Guernsey, three Holsteins and three Ayrshires are pure bred. Twenty-two animals remained in the herd throughout the entire year, and their records are given in the tabulation. Many of the cows giving the lower records have been valuable animals in past years, but have become unprofitable, and some have already been removed from the herd. The average, however, for the herd was 6,671.1 pounds.

As already shown under "Cost of Producing Milk," the foods consumed were only such as to provide a sufficient and well-balanced ration. Soiling crops were fed for practically six months, and silage the remainder of the year. In connection with the weight of the milk which was taken daily, the product from each cow was sampled and analyzed once in two weeks. The accompanying table shows the monthly yield of milk and its composition, as well as the total yield per cow of milk, of fat and of butter. The butter equivalent is derived from the fat by adding one-sixth.

Record of the Dairy Herd.

Name of cow.		April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per cent. of fat.	Total fat.	Equivalent to butter.
Viola	Pounds of Milk	598.7	686.7	568.0	308.5	25.8	....	201.4	941.7	961.6	885.2	686.8	828.4	6,652.8	3.97	263.80	307.99
	Per Cent. of Fat	3.9	4.0	4.1	5.1	4.9	....	4.0	4.2	3.7	3.9	3.7	3.8	....	......	....	....
Hilda	Pounds of Milk	256.1	....	495.7	1,388.6	1,206.2	1,047.8	1,131.8	848.7	1,058.4	967.7	704.8	780.2	9,782.0	3.75	366.89	427.46
	Per Cent. of Fat	4.9	....	4.2	3.5	3.4	3.7	3.8	3.4	3.9	4.3	3.9	4.1	....	......	....	....
Model	Pounds of Milk	1,084.4	1,145.7	1,048.5	798.5	709.7	688.8	728.2	646.7	516.7	404.6	252.4	68.8	7,962.5	4.53	361.31	421.53
	Per Cent. of Fat	4.3	4.2	4.1	3.9	4.6	4.1	3.9	4.3	4.1	4.5	4.7	4.2	....	......	....	....
Select	Pounds of Milk	....	977.6	1,429.6	1,042.2	841.1	750.7	811.4	722.4	601.9	721.1	582.8	378.8	8,804.6	4.36	383.90	447.88
	Per Cent. of Fat	....	4.2	4.6	4.4	3.7	4.3	4.2	4.3	4.7	4.4	4.5	5.0	....	......	....	....
Gipsey	Pounds of Milk	948.9	1,080.0	928.8	707.5	657.1	548.8	366.2	46.4	....	....	112.1	1,150.6	6,490.9	4.13	267.92	312.57
	Per Cent. of Fat	3.9	4.1	4.0	3.9	3.9	4.3	4.7	4.7	....	....	4.0	4.2	....	......	....	....
Pearl	Pounds of Milk	586.7	487.4	858.7	94.8	857.9	842.0	872.8	758.0	820.2	682.5	514.9	628.4	6,989.3	4.43	307.55	358.81
	Per Cent. of Fat	4.4	5.1	5.1	5.6	5.6	4.2	4.1	3.9	4.2	4.2	4.3	4.3	....	......	....	....
Woodlawn	Pounds of Milk	....	....	390.0	1,177.2	988.6	848.8	878.8	762.1	702.8	569.5	286.2	48.0	6,586.0	3.86	254.23	296.60
	Per Cent. of Fat	....	....	4.0	3.4	3.4	4.2	3.7	3.9	4.2	4.4	4.4	4.6	....	......	....	....
Victoria	Pounds of Milk	1,278.8	1,218.7	1,116.8	875.1	785.2	754.8	745.7	629.7	652.7	690.7	618.9	601.9	9,968.5	3 61	359.62	419.56
	Per Cent. of Fat	3.2	3.6	3.7	4.2	3.4	3.8	3.8	3.8	3.4	4.4	3.5	3.7	....	......	....	....

TABLE XI.

Record of the Dairy Herd—Continued.

Name of cow.		April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per cent. of fat.	Total fat.	Equivalent to butter.
Zola	Pounds of Milk	515.0	428.3	269.5	144.1	29.6	638.8	1,046.9	842.1	944.7	226.1	668.5	712.8	7,061.4	4.03	284.48	331.84
	Per Cent. of Fat	4.9	4.9	4.4	4.2	4.2	4.4	3.8	3.7	3.8	3.8	4.0	4.4	...	...	...	...
Blue	Pounds of Milk	331.0	384.1	818.0	639.9	523.3	226.9	...	...	...	945.2	1,129.1	1,075.0	7,072.5	4.37	309.42	360.99
	Per Cent. of Fat	4.2	4.4	4.6	4.7	4.6	5.1	...	...	...	3.6	4.7	4.2	...	...	...	...
Raritan	Pounds of Milk	242.5	1,008.4	980.6	761.2	670.6	690.5	519.2	351.2	90.1	...	...	1,090.5	6,287.3	4.11	258.58	301.62
	Per Cent. of Fat	3.1	4.0	4.1	4.0	3.9	4.2	4.1	4.1	4.2	...	...	4.4	...	...	...	...
Genesta	Pounds of Milk	1,075.7	1,044.6	959.8	746.1	648.1	559.8	519.1	229.3	...	...	...	...	5,782.5	4.19	242.18	282.49
	Per Cent. of Fat	3.9	4.4	3.9	4.2	3.7	4.7	4.3	5.6	...	...	...	...	...	...	...	...
Luella	Pounds of Milk	396.8	1,018.3	967.6	723.1	626.5	557.6	451.5	426.6	342.2	286.6	41.1	...	6,332.4	4.66	294.92	344.07
	Per Cent. of Fat	4.5	4.8	4.5	4.6	4.1	5.6	5.1	5.5	4.7	5.9	6.7	...	...	...	...	...
Roma	Pounds of Milk	340.3	443.6	361.1	114.4	...	...	...	490.4	1,115.9	380.0	649.9	720.1	5,065.7	4.37	221.18	257.99
	Per Cent. of Fat	4.2	4.2	4.5	5.3	...	...	...	4.5	4.4	4.6	4.2	4.0	...	...	...	...
Daisy	Pounds of Milk	715.6	747.3	704.0	553.6	446.5	422.3	389.2	266.9	187.5	19.5	...	576.5	5,029.9	5.52	277.50	323.75
	Per Cent. of Fat	5.1	5.3	5.3	4.9	5.1	6.0	6.2	5.5	6.5	6.5	...	5.7	...	...	...	...
Evesta, 5th	Pounds of Milk	457.4	435.3	272.6	291.6	240.0	49.2	...	...	...	301.3	652.2	564.7	3,845.3	4.26	163.80	191.10
	Per Cent. of Fat	4.2	4.2	3.5	4.4	4.7	4.6	...	...	...	4.6	3.9	4.3	...	...	...	...

TABLE XI.

Record of the Dairy Herd—Continued.

Name of Cow.		April.	May.	June.	July.	August	September.	October.	November.	December.	January.	February.	March.	Total yield.	Average per cent. of fat.	Total fat.	Equivalent to butter.
Cherry	Pounds of Milk......	....	....	27.6	1,099.8	988.9	811.3	790.7	633.9	566.5	498.9	335.3	200.7	5,953.6	4.41	262.79	306.59
	Per Cent. of Fat.....	....	....	5.4	4.8	3.9	4.4	4.5	4.0	4.3	4.6	4.4	5.6	....	.....	....	....
Regena	Pounds of Milk......	356.4	272.8	47.8	....	339.3	781.3	753.4	579.0	462.6	443.6	340.6	299.8	4,676.6	3.95	184.94	215.76
	Per Cent. of Fat.....	4.3	4.5	4.8	....	3 8	3.9	3.4	3.5	4.6	4.0	3.8	4.6	....	.....	....	....
Ideal	Pounds of Milk	713.2	697.0	695.8	498.5	412.0	332.9	176.7	....	854.9	875.7	674.9	747.2	6,978.8	4.53	302.76	353.22
	Per Cent. of Fat.....	4.3	4.9	4.7	4.7	4.8	6.(	6.0	....	4.3	3.9	4.1	4.4	....	.....	....	....
Queen........	Pounds of Milk......	1,422.8	1,419.6	1,207.2	813.1	680.8	671.0	712.2	455.6	278.2	18.2	....	1,178.4	8,857.1	4.07	360.22	420.26
	Per Cent. of Fat.....	4.1	4.5	3.6	4.1	3.7	4.2	4.3	4.0	4.4	4.4	....	3.9	....	.....	....	....
Alta	Pounds of Milk......	785.2	720.6	642.6	551.6	459.4	224.4	....	....	....	....	436.9	1,041.3	4,862.0	3.80	184.93	215.75
	Per Cent of Fat.....	3.7	3.7	3.6	4.1	4.0	4.9	....	....	....	....	3.8	3.6	....	.....	....	....
Sebolt.........	Pounds of Milk......	526.8	472.1	355.9	196.1	11.5	677.9	750.3	673.8	648.1	659.4	551.8	544.2	6,067.9	4.61	279.65	326.26
	Per Cent. of Fat.....	4.6	5.2	4.5	4.5	4.5	4.3	4.5	4.2	4.4	4.7	4.9	5.1	....	.....	....	....
	Average..........	....	....	....	....	....	....	....	....	....	....	....	....	6 671.1	4.22	281.40	328.87

In a herd of grade cows, representing several breeds, it is natural that there should be a wide variation both in the yield and composition of the milk produced by the individual animals. While there are two distinct classes of dairy cows, viz., milk producers and butter producers, there are also many animals of mixed breeding which combine these two characteristics in a remarkable degree. This point is clearly brought out in the following tabulation: 1. Yields of Milk; 2. Yields of Butter; 3. Yields of Milk and Butter from animals which combine, in a marked degree, the qualities of milk and butter production.

1. Yields of Milk.

1 cow....	.....an average of	more than	3,000 lbs.	and less than	4,000 lbs.
2 cows.........	"	"	4,000 "	"	5,000 "
4 "	"	"	5,000 "	"	6,000 "
8 "	"	"	6,000 "	"	7,000 "
3 "	"	"	7,000 "	"	8,000 "
2 "	"	"	8,000 "	"	9,000 "
2 "	"	"	9,000 "		

The best cow produced..	9,953.5 lbs.
The poorest cow produced......................................	3,845.3 "
Difference between highest and lowest......................	6,108.2 lbs.
Average per cow..	6,671.1 "

2. Yields of Butter.

1 cow..............	an average of	more than	150 lbs.	and less than	200 lbs.
2 cows............	"	"	200 "	" "	250 "
3 "	"	"	250 "	" "	300 "
8 "	"	"	300 "	" "	350 "
3 "	"	"	350 "	" "	400 "
5 "	"	"	400 "	" "	

The best cow produced..	447 lbs.
The poorest cow produced......................................	191 "
Difference between highest and lowest......................	256 lbs.
Average per cow..	328 "

3. Yields of Milk and Butter.

From animals which combine, in a marked degree, the qualities of both milk and butter production.

Name.	Breed.	Yield of Milk.	Yield of Butter.	Fat.
		lbs.	lbs.	%
Ideal	Grade Holstein	6,678	353	4.53
Pearl	" "	6,939	358	4.43
Zola	" "	7,061	331	4.03
Blue	" "	7,072	360	4.37
Model	" Jersey	7,982	421	4.53
Select	" Shorthorn	8,804	447	4.36
Queen	" Holstein	8,857	420	4.07
Hilda—Pure Bred	"	9,782	427	3.75
Victoria	Grade "	9,953	419	3.61

It has been shown that the cost of rations per cow per day was 12.88 cents, or a total of $47.01 per year. Following the same line of comparison, the advantages of the better cows are shown in the following tabulation:

	At 1 cent per lb.	At 3 cents per qt.	Cost of Food.	Gain over Food. At 1 cent per lb.	Gain over Food. At 3 cents per qt.
Average value of product of 15 cows, yielding more than 6,000 lbs. of milk.	$74 36	$102 36	$47 01	$27 35	$55 35
Average value of product of the 7 cows, yielding less than 6,000 lbs. of milk....	50 30	69 21	47 01	3 29	22 20
Value of product of average cow	66 71	91 80	47 01	19 07	44 79

At 1 cent per pound, the yield of the fifteen cows, producing more than 6,000 pounds of milk, is sufficient to pay for their food and $27.35, besides manure, while the average yield of the seven cows, producing less than 6,000 pounds of milk, is sufficient to pay for their food and only $3.29, besides manure; a difference of $24.06 in favor of the better cows. At 3 cents per quart, the returns from the cows yielding over 6,000 pounds of milk, over cost of food, are increased to $55.35, while for the cows yielding less than 6,000 pounds they are increased to $22.20, or less than one-half of those of the better cows at 1 cent per pound.

The facts brought out by this study indicate that but little profit

can be derived from a cow that does not produce 5,000 pounds of milk per year, particularly if the milk is sold at the low price of 1 cent per pound. No stronger argument is needed in favor of the necessity of testing the animals, and thus learning their exact value, than is afforded by the above records.

When butter is made, practically all the fertilizing elements in the whole milk remain upon the farm, and these, together with the feeding value of the skim-milk, which is estimated by careful dealers to be 20 cents per hundred, is an offset against the extra labor in making butter.

	20 cts. lb.	Foods.	Gain over Food.
Average value of product of the 16 cows, yielding over 300 lbs. of butter	$72 06	$47 01	$25 05
Average value of product of the 6 cows, yielding less than 300 lbs. of butter	48 86	47 01	1 85
Value of product of average cow	65 67	47 01	18 66

The tabulation shows that the sixteen cows, yielding over 300 pounds of butter, paid for their food and $25.05 in addition to skim-milk and manure, while the manure and skim-milk of the six cows, yielding less than 300 pounds of butter, represent the pay received for their care and the labor of making the butter, with $1.85 additional. The facts brought out by the above records indicate that there is but little profit from a cow that does not produce 200 pounds of butter per year, and point to the necessity of a careful selection of cows for the butter dairy.

Average Analyses of Herd Milk.

It was desired at the outset to build up a herd that would produce milk containing at least 4 per cent of butter fat. The average per cent. in the herd milk has exceeded this amount each year, as shown by the following:

1897	4.25	per cent. fat.
1898	4.44	" "
1899	4.50	" "
1900	4.57	" "
1901	4.33	" "
1902	4.39	" "

Wastes in Handling and Delivery.

A careful record has been kept of the amount of milk wasted in handling, cooling and delivering. The waste during the past six years is shown in the following tabulation:

	Waste in Handling, Cooling and Bottling. per cent.	Waste in Delivery or Dippage. per cent.	Total Waste. per cent.
1897	5.7	5.1	10.8
1898	4.4	4.9	9.3
1899	4.8	2.0	6.0
1900	4.7	1.7	6.4
1901	3.8	1.7	5.5
1902	.8	1.2	2.0

During the years 1897 and 1898 about 50 per cent. of the milk was bottled, so that the actual loss due to dippage was practically 10 per cent. For the past four years the proportion of milk delivered in bottles has been gradually increased and the waste this year was reduced to 1.2 per cent. While the use of bottles increases the expense of delivery, due to extra weight on the wagon, the extra work of cleaning and the breakage and loss of bottles, which amounted to 10 cents per day per hundred bottles, the decrease in waste, greater cleanliness and better condition of the milk when delivered, has more than offset this extra cost. The tabulation also shows that there has been a decrease from year to year in the percentage of waste in handling, cooling and bottling. This is due largely to improved apparatus and greater care in handling the product.

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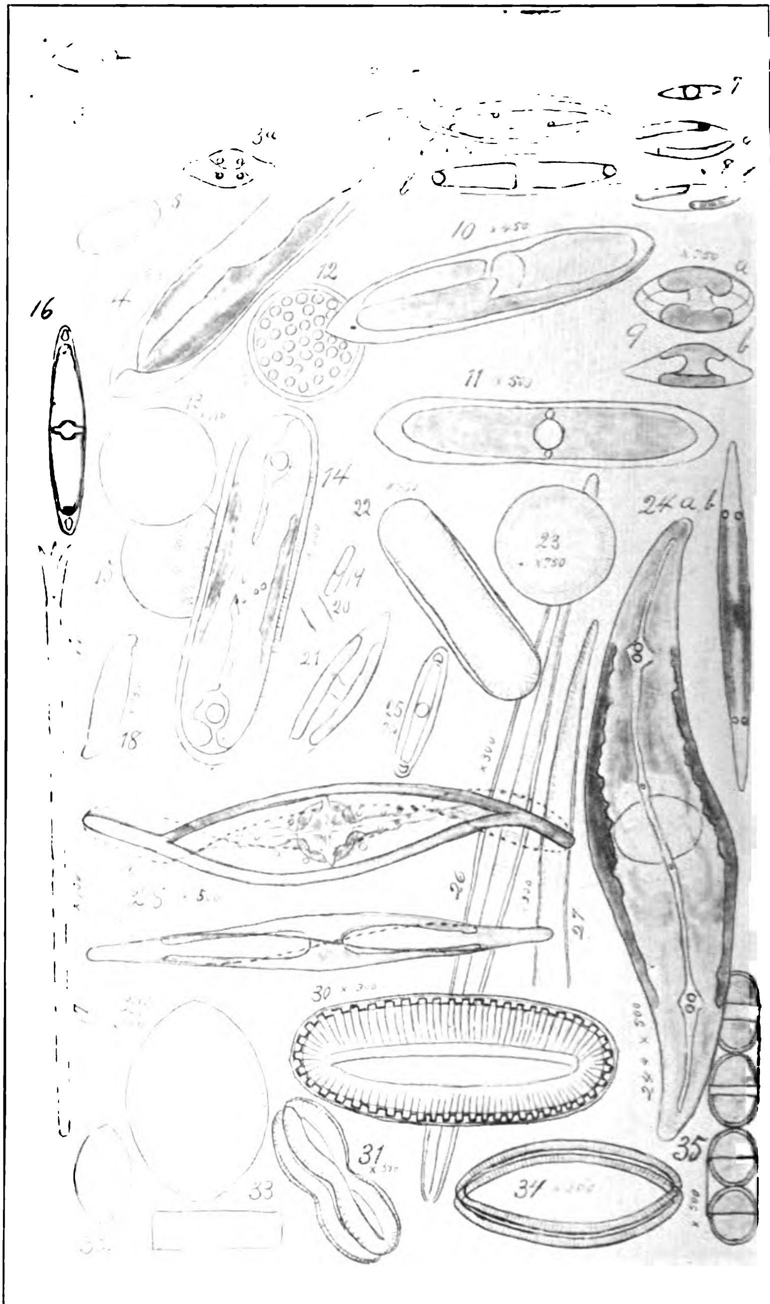
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DESCRIPTION OF FRONTISPIECE.

Most of the diatoms here figured have not been identified, and so only a few will be named. The dark parts in the protoplasmic contents are "chromatophores," usually of a yellowish color; the clear spaces are vacuoles.

Figures 1, 6, 8, 11, 14, 16, 21, 22, 25 are *Navicula*.
Figures 4, 10 are *Amphiprora;* 9, *Cymbella*.
Figures 12, 13, 15, 23 are *Coscinodiscus* species.
Figures 26, 27 are *Nitschias*.
Figures 29, 32 are *Cocconeis* or *Navicula*.
Figure 30, *Surirella*.
Figures 18, 24 are *Pleurosigma*.
Figure 35 is *Melosira nummuloides*.
Figure 33, probably *Diatoma*.

In figures 24 and 28, where two views of the same diatom are given, *a* is the side view, *b* the front view. 24*b* is drawn to smaller scale than 24*a*. In figure 28*a*, the dotted line is the outline of the same frustrule when the bottom edge is raised a little.

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PART I.

EXPERIMENTAL STUDIES IN OYSTER PROPAGATION, 1902.

EARLY DEVELOPMENT OF THE OYSTER EMBRYO.

Sec. 1. Introductory.

The reader of this report who is unfamiliar with the problems involved in oyster culture may, by a few introductory sentences, be enabled to comprehend the particular objects of these researches, for which the State of New Jersey, in 1901, authorized the annual expenditure of the sum of $200. The appropriation therefor has been successively granted by legislative enactment for the seasons of 1901 and 1902.

Oysters, like all living productions, are originated through the natural reproductive processes, and occur in the state of nature on reefs, along certain parts of the seashores, known as "natural oyster beds." Each oyster is at first a very minute egg, of which the parent oyster "spawns out"—*i. e.*, ejects—millions every summer. These eggs rapidly develop into small, free-swimming oyster fry, that in a few days are provided with a bivalved shell; and then they settle down on a clean surface, of a shell or stone, etc., to which they become attached by the left side.

The oyster secures its food by means of "ciliary action"—*i. e.*, the surface of the oyster's gills are covered with very small *cilia,* that are shaped like hairs, and which twirl around in the water and draw a current through the pores of the gills. The very small organisms contained in the water become entangled in a layer of slime which covers the gills; this slime is dragged towards the mouth and into

the stomach, also by ciliary action. Thus feeding, the little oyster grows, in the course of three to five years, to a marketable size.

But, on a natural bed, the oysters are crowded together and become misshapen, and, owing to competition, are poor and ill-flavored. Therefore, the oystermen secure these oysters, knocking the clusters apart and then transplant the individuals (called "seed" oysters) to areas called "oyster lots" or "oyster farms," where each oyster is given plenty of room and opportunity to grow faster and so to attain a better flavor than was possible on the natural bed.

It came to pass that the demand for "seed oysters" was so great that the amount securable from the natural beds has been inadequate to the needs of the oyster planters. Therefore, some of these planters have placed shells on their farms, together with a few spawning oysters, and so started an artificial oyster bed, raising seed of their own. Such beds are at first claimed to be natural beds by those who take seed oysters, and are regarded by them as free to all; they take such seed (belonging to the planters by right of the labor expended) and actually sell to the planters their own property. Gradually, however, through laws enacted and new police regulations, property rights in such private beds become more secure.

One reason why natural beds fail to furnish sufficient seed oysters is because, after many seasons' persistent tonging, the shells which the young oysters need for attachment are carried off with the seed. As natural beds are regarded as public property, no private efforts are made to plant shells on such beds to keep up its productiveness. So the State of New Jersey annually expends thousands of dollars planting shells on some of its natural oyster beds, that the planters may have oyster seed. But even with such aid there is a scarcity of seed. Planters find that there are many areas where oysters may be grown and fattened for market where they nevertheless fail to secure seed by planting shells. In fact, the areas where (with our present knowledge) we can secure seed oysters by planting shells are quite limited. Those areas that were once natural beds, but have become depleted so as no longer to be profitable to work, except in a very small way, can be readily restored to great productiveness by "shelling." Were all such areas "shelled" at State expense there would be seed enough, but at a very great public cost; and it seems just to believe that it were better for private enterprise to develop such areas. Yet, when private enterprise does restore such areas, they

are still generally regarded as "natural ground," in which there can be no "private property rights." Hence, owing to lack of proper protection, many areas that would yield seed oysters lie idle, while the planter meets with but indifferent success or even failure in shelling the ground which he owns. Even on the best natural beds there is great fluctuation in the amount of oyster "spat" that "sets" from season to season.

Now, nobody is able to tell what causes such fluctuation, and so nobody can tell whether or not the oyster-seed production could be made a sure thing. It is therefore eminently desirable to *study the nature of oyster propagation, to learn the laws that govern oyster development. This is the first great object of our researches.*

Then there is the method of "claire culture," so successful in Europe. A *claire* is a pond along the shore, usually artificially constructed, which is carefully tended and whose water-supply is under perfect control. The immense acreage of salt marsh along our borders, when properly ditched, offers an alluring prospect for oyster culture, did we but know just how to provide for the necessities of the young oysters. This problem calls for the discovery of the same secrets as does the general question above stated; hence the *development of claire culture for the American oyster is the second great object of our researches.*

As these ponds would be under absolute control and private ownership, it becomes, ultimately, our *third object to ascertain how to raise oyster seed in such claires,* so oyster-seed production would be a private enterprise, like the production of vegetable seeds on land.

All these questions depend for their solution on a knowledge of the laws of oyster development—*i. e.,* on what is called, in biology, by the term "ecology." *Oyster ecology is our study,* and our experiments are directed to that end and are not primarily such experiments as a practical oysterman would make. We do, indeed, have such practical experiments ultimately in mind. They are the application of the knowledge gained by scientific study, and, in fact, the two kinds of researches are interwoven. But at this early stage of the study the more practical side is kept secondary.

We make this explanation because, previously, experimenters in America have actually succeeded in raising seed oysters in claires and have announced that they have shown that seed can be raised in this way; so it only remains for the oystermen to go ahead. Unfortunately, oyster seed can be raised in such claires at one time and at

another time cannot; and so we are still forced back to the original question—"what are the ecological laws of oyster development?"

We know very well that we cannot expect to raise oysters in glass tumblers, under the conditions obtaining in our experiments. These experiments were made for the sake of ascertaining why, at one time, our oyster eggs developed shells, and not at all times, under, apparently, the same "unfavorable" conditions; for, undoubtedly, a crowd of millions of oyster fry in a tumbler of sea water must be considered as under extremely unfavorable conditions. Yet, under such conditions, we occasionally secured a complete development of the fry up to the "spat" stage.

Evidently, it is needful artifically and with certainty to secure an unlimited amount of fry in the shell stage before we can proceed to study the conditions of spat fixation. Yet just here we have experienced some puzzling and apparently contradictory results, which we discuss in a later part of this report.

During the season of 1901 only one of our batches of oyster fry reached the full "shell stage," while during the season of 1902 this stage was reached at least three or four times at different parts of the summer.

These advanced fry were planted, with cultch, in a tank in which during the previous season (when we had poorer lots of fry), a few oysters had started and attained some growth; yet not a single "set" was secured in this tank during the past season. It is evident that this result is not to be called a "failure" from an experimental standpoint, because, from such a result, we may make the positive assertion that, whatever the reason for such a "failure" may be, it is not due to any lack of constitution in the fry. We must therefore seek for the answer next season in some other direction. In 1901 this answer could not have been given, for it looked, at the close of our work that summer, as if the failure to raise young oysters under the conditions obtaining in the tank was primarily due to lack of constitution in the oyster fry.

In our report for 1901 we paid especial attention to the developmental phenomena involved in the fertilization and early development of the egg. Taking up the history from this point during 1902, we have accordingly studied the next period of development, viz., the early development of the oyster embryo. The data secured under this head are exhibited on Plates I., II. and III.

'hese phases of the history, being more complex than those presented the fertilization of the egg, and also less familiar to the investi- or, have not been so satisfactorily nor so completely worked out as 'e the earlier phases; much therefore remains for future studies complete. The thoroughness of these studies was also interfered h by various incidental investigations, and particularly by a desire iscertain whether the various varieties of oysters differed in their elopmental viability.

Ve had found, at the close of the previous season's work, that only lot of fertilized eggs developed as far as the shell stage. We hed, therefore, to ascertain if possible why the other experimental failed to complete their early development. It seemed to us that re were three possible causes for this failure: (1) the proper iety of oysters was not used; (2) the eggs were not properly idled; (3) the eggs were not in a proper stage of maturity.

Each of these three causes was tested experimentally during the son just past, and while the data secured do not enable us to give illy satisfactory answer to these questions, yet real progress has been le in that a partial answer has been secured.

First of all we found that native seed is not superior in develop- ital vitality to oyster seed imported from distant localities. Con- :y to expectation, southern plants were found to equal or possibly exceed native seed in developmental constitution. We found that *successful viability is not confined to any one variety of seed.*

Next, we found that the most careful handling of the eggs did not n to secure the desired viability in the great majority of the ex- iments. In those experiments that showed the desired viability especial care was taken.

Thirdly, we worked with eggs of the very choicest appearance, and mature as possible, using both those that were just about to be wned out and those that remained after the oyster had begun wning.

Apparently, as a result of careful selection in this regard, we ob- ied a higher percentage of viability during the season just past n during any previous season. This result is in harmony with our damental dictum, viz., that the success of oyster development de- ds on the inherent vitality of the eggs. Nevertheless, there are ie puzzling features connected with the results of our experiments, it seems as if it would be necessary to make a careful study of

natural spawning on natural beds, to clear up these matters. We do not know that when an oyster spawns naturally, all its eggs are able to develop into "sets" in even the most favorable situation. Perhaps the eggs of a proportion of the spawners may not have sufficient viability. Why is there so great a variation in the number of sets produced on the natural beds from year to year?

Captain Joseph K. Ridgway, of Barnegat, President of the State Oyster and Shell Commission, writes me, October 14th, 1902, as follows:

"There was but a light set of spat on the Cedar Creek beds in 1901 * * * there was very little set on shells in any part of Barnegat bay this summer. Prices are at least twenty-five per cent. higher than last year, and 'plants' are hard to get. * * * It sometimes happens that a fair set will adhere to shells on one part of an oyster lot and none on other parts. Why this is so we cannot tell. We wish we could."

George A. Mott, of Tuckerton, Secretary of the Commission, wrote me, October 24th, 1902, to wit, "The catch this year is very light and late. We had a fine lot of plants gathered from the beds at the mouth of Mullica river."

Watson T. Sooy, of Green Bank, wrote, October 20th, as follows: "There was a light (late) catch on all shells in the Mullica river. The first I examined were about the 20th of September."

We may make guesses at the cause of this partial failure of nature to provide a set on the shells placed in proper position by man. We may say there was a lack of spawning oysters, or the eggs were not properly matured, or the shells were not planted at the right time, or the summer was too dry and cool, or that the water was too salt or too fresh, etc., etc., but no one *knows* anything for certain about it, simply because the matter has never been the subject of continuous, scientific inquiry.

Yet this problem *must* be solved before we can develop a good system of artificial oyster propagation. It is to answer such a question as this that this work was undertaken. It is clear that it is a matter requiring time and patience and even additional experimental workers.

It is hoped that the small appropriation authorized by the State will be continued to be appropriated as long as the experiments are thought worthy of continuance. Certainly the matter should be thoroughly investigated and not abandoned so long as there is hope of ultimate success and so long as progress is being made towards the wished-for goal.

Sec. 2. Journal of Operations.

The work of the season of 1902 began a week earlier and continued a week later than during the previous season. This was due to the fact that for some reason the oysters matured earlier than usual and remained in a spawny condition longer than usual. The first oysters were opened June 12th and were found to have completed spawning. The last spawn was taken September 3d. Not all the time intervening between these dates was spent at the Station. In all, the investigator passed an average of four days per week for ten weeks at Mott Station, engaged in various experiments and studies, bearing on the problems stated in our introduction. The results are exhibited in the text and plates of this report. These results may be classified under the following heads: (1) Development of the oyster embryo; (2) Oyster food; (3) Comparative viability of different kinds of oysters; (4) Oyster parasites; (5) Enemies of the oyster fry, and other incidental experiments. In fact, the work was really too varied for much progress to be made in any one direction. Yet such varied general surveys are necessary to aid in planning future work.

Visits were made to Barnegat for the first two weeks, but the conditions here being quite unfavorable for the experiments, we thenceforth confined our attention to Mott Station, at the mouth of Stopwater Creek, on the Great Bay meadows, four miles south of Tuckerton, at which place we secured as fine specimens of "spawny" oysters as we ever saw for the longest period in our experience.

The successive lots of oysters opened are indicated by the Roman numerals; the kind of oysters, their condition and history, the number of ripe males and ripe females secured, the hours and dates when they were opened, are indicated in the first of the following tables.

The next table indicates by Arabic numerals the successive lots of spawn fertilized and started on the developmental path; the oyster lots from which the spawn was secured and the date and hour of starting the experiments.

The third table shows the temperature at different times of the day, on important days of the investigation. The data were not secured for the first two weeks, owing to lack of thermometer, later secured.

Next follows a description of the experiments and their results.

Table of Oysters Used in Experiments.

ABBREVIATIONS: N.—Natives; B.—Bays; Cr.—Creek; E. R.—East River; H. I.—Hog Island Virginias; Gr.—Great; El.—Elder; Barn.—Barnegat; Tuck.—Tuckerton; Opnd.—Opened; Spnd.—Spawned.

DATE.	Hour opened.	Lot.	Designation.	Condition and history.	Ripe males.	Females.	Condition of eggs.
June 12	1:30 P. M.	I	N. Barn. B.	Half spnd.	......	......	
" 12	1:30 P. M.	II	N. " Cr.	About "	......	......	
" 13	9:30 A. M.	III	E. R. Barn	Nearly "	......	......	
" 13	5:00 P. M.	IV	E. R. Tuck	About "	......	......	
" 13	5:00 P. M.	V	N. "	Good.	......	......	
" 13	5:00 P. M.	VI	H. I. "	Very good.	......	......	
" 17	12:00 NOON	VII	N. Barn. Cr.	Freshened on Float	1	1	Opake, Vesicular.
" 17	12:00 NOON	VIII	N. " B.	" " "	0	0	
" 17	2:00 P. M.	IX	N. " Cr.	From bottom, 22 discarded	1	1	Not ripe.
" 18	3:30 P. M.	X	H. I. pond.	Very good.	3	4	Irregular.
" 18	3:30 P. M.	XI	H. I. Gr B.	Good	1	3	Granules outside eggs.
" 18	3:30 P. M.	XII	N. El. Cr.	Fair.	2	6	
" 24	4:00 P. M.	XIII	Mixed Cr	"	3	4	
" 24	4:00 P. M	XIV	N. El. Cr.	Only one "good."	1	6	
" 24	4:00 P. M.	XV	H. I. Gr. B.	Good.	2	3	
" 24	4:00 P. M.	XVI	H. I. pond.	"	4	9	Granular.
" 25	10:30 A. M.	XVII	N. Mullica.		......	......	
" 26	12:00 NOON	XVIII	N. El. Cr. (float).	Good.	......	......	
July 7	12:00 NOON	XIX		Mott's experiment.	......	......	
" 9	10:30 A. M.	XX	Mixed Cr.	Part spnd.	4	9	
" 9	5:00 P. M.	XXI	Clams.	Immature.	9	5	
" 9	7:00 P. M.	XXII	Cr. bank.	Good, put naked into sea water.	1	1	Part decomposed.

Table of Oysters Used in Experiments.—Continued.

ABBREVIATIONS: N.—Natives; B.—Bays; Cr.—Creek; E R.—East River; H. I.—Hog Island Virginias; Gr.—Great; El.—Elder; Barn.—Barnegat; Tuck —Tuckerton; Opnd.—Opened; Spnd.—Spawned.

DATE.		Hour opened.	Lot.	Designation.	Condition and history.	Ripe males.	Females.	Condition of eggs.
July	15	8:00 P M.	XXIII	E. R. Cr.	All spnd.	......	......	
"	15	4:00 P M.	XXIV	Cr. bank.	Fine, put naked into tank	7	9	
"	16	12:00 NOON	XXV	" "	" " " " "	1	5	
"	17	4:00 P M.	XXVI	' " (?).		......	......	
"	18	7:00 A. M.	XXVII	" " mixed El. Cr. N.	Fine, put naked into tank	2	2	
"	18	12:00 NOON.	XXVIII	H. I. pond.	" " " " "	8	8	
"	22	4:00 P. M.	XXIX	Cr. bank, H. I. pond.	8 discarded	2	2	
"	22	4:00 P M.	XXX	Cr. bank, N. pond.	Best, 4 discarded.	1	8	
"	29	5:30 P. M.	XXXI	" " " "	Good.	1	1	Granular.
"	29	5:30 P. M.	XXXII	Cr. bank, H. I. pond.	Very good.	2	4	
Aug.	5	12:00 NOON	XXXIII	Cr. bank.	All spnd.	......	......	
"	5	12:00 NOON.	XXXIV	H. I. pond.	Good.	8	5	
"	26	5:00 P. M.	XXXV	N. pond.	"	5	8	
"	26	5:00 P. M	XXXVI	H. I. pond.	"	1	1	
Sept.	2	8:00 A. M.	XXXVII	Cr. basket.	About spnd	2	1	Poor.
"	2	6:00 P M.	XXXVIII	H. I pond.	Spawned out.	......	......	
"	2	6:00 P. M.	XXXIX	N. pond	Nearly spnd. out	8	1	
"	8	9:30 A. M.	XL	N. pond.	" "	2	1	

Table of Fertilization Experiments.

DATE.	Number.	Hour.	Oysters used.	DATE.	Number.	Hour.	Oysters used.
June 12...	1	2:00 P. M	I., II.	July 18...	21	12:30 P. M.	XXVIII.
" 13...	2	10:00 A. M.	III.	" 18...	22	3:45 P. M.	XXIV., soaked.
" 13...	3	5:00 P. M.	IV., V., VI.	" 19...	23	10:00 A. M.	XXIV., XXV., XXVII., XXVIII. all soaked.
" 17...	4	12:30 P. M.	VII.	" 22...	24	4:30 P. M.	XXIX., XXX.
" 17...	5	2:30 P. M.	IX.	" 29...	25	6:00 P. M.	XXXI., XXXII.
" 18...	6	4:00 P M.	X., XI., XII.	Aug. 5...	26	12:30 P. M.	XXXIV.
" 18...	7	5:45 P M.	X., XI , XII.	" 26...	27	6:00 P. M.	XXXV., XXXVI.
" 24...	8	4:45 P M.	XIII., XIV., XV., XVI.	Sept. 2...	28	8:30 A. M	XXXVII.
" 25...	9	11:00 A. M.	XVII.	" 2...	29	6:30 P. M.	XXXVIII., XXXIX.
" 26...	10	12:30 P. M.	XVIII.	" 3...	30	10:00 A. M.	XL.
July 7...	11	....	XIX.				
" 9...	12	11:00 A. M.	XX.				
" 9..	13	5:30 P. M.	XXI.				
" 10...	14	9:15 A. M.	XXII., soaked.				
" 11...	15	5:00 P. M.	XXII., soaked.				
" 15...	16	5:00 P. M.	XXIV.				
" 16...	17	1:00 P. M	XXVI., clams.				
" 17...	18	3:00 P. M.	XXIV., soaked, XXV.				
" 17...	19	4:30 P. M.	XXIV., soaked. XXV., soaked.				
" 18...	20	7:15 A. M	XXVII.				

Air Temperature (Fahr.) at Mott Station.

DATE.		Hour.	Degree.
June	24..	4:30 P. M.........	78
"	24..	7:00 P. M.........	70
"	25..	7:00 A. M.........	65
"	25..	12:00 NOON.......	75
"	26..	12:00 NOON.......	76
"	27..	5:00 P. M.........	82
July	9..	7:00 A. M.........	80
"	9..	10:00 A. M.........	85
"	9..	12:00 NOON.......	85
"	9..	7:00 P. M.........	80
"	10..	8:00 A. M.........	84
"	10..	10:00 A. M.........	88
"	10..	3:30 P. M.........	84
"	10..	6:00 P. M.........	80
"	11..	6:00 A. M.........	60
July	15..	12:00 NOON.......	84
"	15..	6:00 P. M.........	78
"	16..	9:00 A. M.........	76
"	16..	5:00 P. M.........	82
"	17..	8:00 A. M.........	70
"	17..	8:00 P. M.........	80
"	18..	7:00 A. M.........	80
"	18..	10:00 A. M.........	88
"	18..	4:00 P. M.........	82
"	19..	7:00 A. M.........	72
July	22..	4:30 P. M.........	84
"	23..	7:00 A. M.........	68
"	23..	3:30 P. M.........	80
"	23..	7:00 P. M.........	74
"	24..	7:30 A. M.........	74
"	24..	12:00 NOON.......	80
"	25..	8:00 A. M.........	72
"	25..	12:00 NOON.......	70
July	29..	4:00 P. M.........	80
"	29..	8:00 P. M.........	80
"	30..	7:00 A. M.........	78
"	31..	8:00 A. M.........	74
"	31..	12:00 NOON.......	80
Aug.	1..	7:00 A. M.........	72
Aug.	5..	12:00 NOON.......	82
"	5..	4:00 P. M.........	84
"	6..	6:00 A. M.........	75
"	6..	9:00 A. M.........	80
"	6..	12:00 NOON.......	82
"	7..	10:00 A. M.........	75
Aug.	26..	6:00 P. M.........	77
"	27..	6:00 A. M.........	67
"	27..	9:00 A. M.........	77
"	27..	11:00 A. M.........	80
"	27..	12:00 NOON.......	82
Aug.	29..	6:00 A. M.........	67
Sept.	2..	7:00 A. M.........	80
"	2..	12:00 NOON.......	82
"	2..	7:00 P. M.........	82
"	2..	10:00 P. M.........	80
"	3..	7:00 A. M.........	70
"	2..	12:00 NOON.......	80
"	2..	7:00 P. M.........	77
"	4..	7:00 A. M.........	75
"	4..	12:00 NOON.......	77
"	4..	7:00 P. M.........	70

Description of the Experiments.

June 12th, Thursday.—In houseboat of Captain J. K. Ridgway, at Barnegat. Opened (lots I., II.) native oysters from creek and from bay; both nearly through spawning; the former most advanced. Also the plants from East river (III.) were about through spawning.

Experiment 1. Spawn lots *a* and *b* prepared from I. and II.

Experiment 2 was prepared next morning from III.

June 13th, Friday afternoon.—At Mott Station. East River plants (IV.) nearly spawned out; natives (V.) in fair spawning condition; Hog Island (southern) plants (VI.) best of all.

Experiment 3. Spawn lots *a*, *b* and *c* were prepared from IV., V., and VI., and left in dishes on table.

An incursion of drumfish had invaded the planted oyster-beds at Tuckerton, crushing the oysters in their capacious jaws with their powerful throat grinders and threatening the total destruction of the crop. Finally, the planters exploded dynamite in the water, with apparent success, killing great numbers of the fish and probably succeeded in frightening the rest away, but not until after a large proportion of the planters had lost their entire stock.

June 17th, Tuesday.—At Barnegat; found spawn lots 1 and 2 of previous Thursday decomposed. Recent heavy rains had made the water of the creek nearly fresh. This water was still quite fresh the following Friday, containing only half a per cent. of salt.

The native creek plants (VII.) and from bay (VIII.) had been left on a float, where they had felt the greatest influence of the fresh water. The eggs were decomposing in the oysters and were entirely unfit for use in VIII. So selected some creek natives that had not been removed from the bottom, but out of one dozen opened we found only one ripe male and one nearly ripe female.

Experiments 4 and *5* were prepared from VII. and IX., but no development followed. This was due either to the effect of the fresh water on the oysters or on the spawn, probably both causes acting successively.

June 18th, Wednesday.—At Mott Station lively embryos were found in spawn lots 3. *a*, *b*, *c*. but, also, there was an extensive development of infusors. One embryo was seen in lot 3*c* (Hog Island plants) that had reached the shell stage. This statement does not mean that only *one* such embryo was present, but that, on account of the smallness

of the fry, a high magnification was necessary to examine them, and this involves a correspondingly restricted field, so that hundreds of other embryos in the shell stage may have been present, but escaped observation by not being included in the few drops of water taken for examination.

Opened lot X., Hog Island plants, from the pond; found three ripe males and four spawny females; two of these were opened an hour or two before the others. From these seven, prepared spawn lot 6*a*.

Lot XI. consisted of Hog Island plants, from the pond; one male and three females. Spawn lot 6*b* prepared from these, and sperms from lot X. also added.

Lot XII., Elder Creek naturals (with least spawn); two males and six females chosen; also added sperms from X. and XI., to make spawn lot 6*c*.

Experiment 6. Prepared from X., XI. and XII., then divided the lot into six portions.

Experiment 7. From same oysters as 6, making separate fertilization of each female, with mixed sperms of all the males.

Next morning, Thursday, June 19th.—All lots of 6 and 7 show good swimming embryos except 7, XII.*c*, but those from XI. and XII. were weaker than in X. The embryos were carefully separated from *debris*. They seem to be attracted to the illuminated side of the tumblers, ascending to the surface and descending in columns, as shown on Plate IV.

Cleaned tank. Weather showery and becoming warmer.

June 20th, Friday morning.—All the lots of *Experiment 6*, now thirty-eight hours old, were in shell stage and swimming on the bottom. They were planted in the tank with cultch of various sorts —wood, stones, shells. Tuesday, June 24th, these were examined, but showed no signs of a "set."

June 24th, Tuesday.—*Experiment 8*. From XIII. to XVI., inclusive. Comparison of four sorts of oysters. Pond (Hog Island) still keep up their reputation as superior, yet none of this lot reached the shell stage.

June 25th, Wednesday.—Mr. W. T. Sooy brought natives from Mullica river (lot XVII., *Experiment 9*).

Studied rotation of the swimming fry of *Experiment 8*, sixteen hours old. Calling the broad end of the embryo the front, where the polar globule is situated, and where a special circle of long cilia is first developed, and the hollow side the belly, as seen in the microscope, the

embryo swims forward and at the same time turns a somersault by throwing the head down and posterior end up; also, at the same time, seen from behind, it turns on the longitudinal axis in same direction as the hands of a watch. In a "life-box" the fry soon use up all the air, and then those next an air bubble rotate on the longitudinal axis only, having the front against the bubble. Those at a distance from such bubble turn on the horizontal axis only, or spin round in a circle. When first placed in the life-box the normal spiral course is maintained.

Some of these embryos were planted in the tank from day to day. None reached the shell stage by Friday, June 27th, when they were seventy-five hours old.

June 26th, Thursday.—Windy, heavy rain fell last night. Fertilixed good naturals from Elder creek that had been on float in Stopwater creek, and secured a good development (*Experiment 10*). These were planted in tank when four and a half hours old.

June 27th.—Investigated improved ditching machine at work on marsh owned by the Sooys, at Chestnut Point, on the Mullica, below the bridge from New Gretna. Filtered water from tank and found embryos in same stage as those lately planted.

July 8th, Tuesday.—Found the best embryos in the flat dishes of lot XIX., fertilized by Mr. Mott yesterday. This lot gradually died out without giving further results of value.

July 9th, Wednesday.—Prepared *Experiment 12* from creek oysters (XX.). These had partly spawned out; the eggs in such individuals appear partly decomposed. It seems as though only the eggs spawned out first are good, and probably, in a state of nature, very few oysters succeed in completely emptying their generative ducts. The eggs remaining are absorbed. Specific gravity of the creek water was 1,017. This was maintained nearly steadily throughout the season; it is also a degree of saltness quite suitable for oyster culture.

Fry of *Experiment 12* was kept in dishes floated in the tank, because of the high air temperature, but it became much cooler at end of the week. This lot became invaded by infusors and the fry decomposed, but not until they had begun to show the rudiments of the shell at forty-three hours.

Experiment 13. Fertilized the eggs of five female clams by sperms from nine male clams. Clam eggs have a thick, jelly-like coating outside a thin, firm shell that rests on the yolk. No special micropyle

visible. The sperms penetrated the outer coat readily at any point. empty shell was soon covered by sperms. This experiment red in a lot of lively embryos in three and a half hours, but the morning, thirteen hours later, they had all died.

ly 10th, Thursday.—Opening oysters for supper, we found two otionally spawny oysters (XXII.), that proved to be one of each the genital ducts showing nicely in the male. Though they had opened, they were placed in sea water over night and subsequently ferred to a small float in the tank, where they were kept several . The spawn was carefully pressed from the ducts by the natural ings and not cut off, as in our previous practice. Thus we kept same specimen, taking spawn from day to day, but even at the taking of spawn the eggs had decomposed in part. Four subset lots of oysters opened were treated in a similar manner, soaking ed" in sea water.

xperiment 14 was prepared from XXII., that had soaked all night a water. The dishes were floated in the tank to keep from becomexcessively hot; the water in the tank rarely rising above 82° F. few hours we had a fine-looking lot of embryos, but by next day ing, when only thirty-one hours old, they were about all dead, as those in lot 12.

ly 11th, Friday.—Saw dredge work at Chestnut Point. The water ie Mullica was practically fresh. The shells in the cove bore dead s" of last season, but none of the present season.

xperiment 15. Prepared from the oysters (XXII.) soaked fortyt hours. Floated the dishes over night and found nice-looking ryos next morning, July 12th. These were planted in the tank, came to nothing.

his experiment shows that rather rough handling of oysters will prevent early development from occurring, although even a slight unt of unnatural treatment of oysters will prevent the eggs from loping in the later stages.

ly 15th, Tuesday.—Following a very hot day. Oysters (XXIV.) on the bank at the creek and exposed to the sun at low tide; proved of spawn, whereas eastern seed, submerged, was entirely spawned

xperiment 16. Prepared from XXIV. Part planted at fourteen rs; mostly dead at thirty-nine hours. A few live eighty-six hours, not yet in shell stage.

Experiment 17. Fertilization of clams; no success. Temperature of water in creek 76°; in tank, 72°.

July 16th.—Studied contents of the gray ooze which covers the black mud. The gray coating consists of living organisms, largely diatoms, the main food of the oyster. The deeper and darker mud contains the skeletons of diatoms, grains of sand, carbonized relics of cellulose walls, dead and living bacteria, etc.

Oysters XXIV. were left attached to their right valves, covered by the left valves and placed in the tank. This treatment so disturbed their functions that, whereas the ciliary action had accumulated lots of food-laden slime, this had failed to reach the mouth, but was heaped up in various places on the body.

The water in the tank was 76° F., two degrees cooler than outside in the creek, and four degrees cooler than the air.

July 17th.—*Experiment 18.* Prepared from XXIV., soaked nearly two days, and XXV., soaked nearly one day, naked, in sea water, to determine whether eggs and sperms, after such soaking, unite at once or still retain the latent period of ten minutes (found last year in fresh spawn), but the experiment did not prove very satisfactory or conclusive. An earlier experiment with spawn from fresh oysters seemed to show that when the spawn is expressed and then soaked ten minutes, the latent period disappears.

Experiment 19. Fertilized spawn lot from XXIV. gives a fine lot of fry next day at fifteen hours, but at thirty-nine hours it was destroyed by infusorial development.

July 18th, Friday.—*Experiment 20.* Oysters XXVII., natives and mixed from Elder creek, that had lain on the bank of Stopwater creek, on being opened, presented some splendid-looking specimens of spawning oysters. The spawn prepared from them scarcely developed.

Experiment 21. From pond, Hog Island (XXVII.), freshly brought in, showed a fair development at twenty hours. Planted in tank, but failed to become spat.

Experiment 22. From XXIV., soaked seventy hours; after sixteen hours shows many infusors and a few fry.

Lots XXVII. and XXVIII. were put naked into the tank. In the old lots (XXIV., XXV.) the heart had ceased to beat.

Studied mode in which Gammarus, a water flea, captures oyster spawn.

July 19th.—*Experiment 23.* Only two oysters in the four lots scar-

in the tank have their hearts still beating. Spawn was taken from others and fertilized and planted at once.

ily 22d, Tuesday.—Oyster lot XXIX.; same as XXVIII., but had left since the 18th on the banks of the creek, where they were red only at high tides.

xperiment 24. Used Hog Islands (XXIX.) and natives (XXX.) n pond left on creek bank since last week; the latter appeared er than the former, but the former came out ahead in the devel- ent, though this became abortive, in both cases, before the close he week; the temperature had been kept fairly level by floating dishes in the tank. This lot of embryos showed a peculiar flagel- , just back of the position of the future mouth, not noticed in r lots. See Figures 14, 15, Plate II. The beginning of a shell noticed after forty-four hours, but the velar disk was very pe- ar in being covered by a transparent, shell-like layer and lacking . None survived beyond the end of the week.

ily 29th, Tuesday.—*Experiment 25.* From XXXI. and XXXII., lving one native female and four Hog Island females; one native e and two Hog Island males fertilized as follows:

a. N. female by N. male.
b. N. female by H. I. males.
c. H. I. females by N. male.
d. H. I. females by H. I. males.
e. Separate females by mixed males.

he second Hog Island female was the only one with fine eggs; *a* better than *d,* and *c* than *b,* thus showing advantages of crossing. t of these fry reached the shell stage at sixty hours and survived ghty-three hours. The formation of the shell was delayed, though temperature ran uniformly, nearly 80°. Hence the lot must be idered somewhat abnormal.

ome of the lots, at forty-two hours, showed the embryos fusing ther by twos and threes. The development of infusors was rapid, Studied ciliary movement.

n August 1st, Friday, at sixty-eight hours, the spawn was thus:

a. Infusoriated, a few reach shell stage.
b. Very few left, and only early shell stage reached.
c. and d, many lively, but abnormal.

On August 2d, Saturday, at eighty-three hours, the Hog Island female, by native male, best of the four lots, but shell stage not properly developed. A few in shell stage in native female by Hog Island female, but not fairly successful.

August 5th, Tuesday.—Found that the oysters on the creek bank so very "spawny" last week had emptied themselves.

Experiment 26. From oysters XXXIV., females as follows:

a. Pond native, eggs granular, little spawn.
b. H. I. from pond, eggs better, more spawn.
c. H. I. from pond, eggs coarsely granular, still more spawn.
d. H. I. from pond, eggs irregular and slightly granular, most spawn.
e. H. I. from pond, eggs nearly like *d.*
f. H. I. from pond, eggs nearly like *a.*

In four hours the embryos were rising, making a fine show in *c*, *e* and especially *b*; poor in others. Added rainwater at night to counterbalance evaporation. At forty-six hours no sign of a shell, except in few accidentally introduced into the tumblers containing diatoms for study. Fry survived until end of week, when they were planted.

August 26th, Tuesday.—*Experiment 27.* With XXXV. and XXXVI., as follows:

a. N. females by mixed sperms.
b. N. female by H. I. male, poor results.
c. N. female by N. male, good result.
d. H I. female by mixed sperms.
e. N. female by H. I. male.
f. H. I. female by N. sperms, best results.

Good development; embryos streaming at fourteen hours; planted half of fry. Rest failed to reach shell stage and were decomposed by end of week.

September 2d.—Pond natives in basket on creek bank about spawned out. New lot of oysters from pond also well advanced, but secured some spawn for *Experiments 28* and *29* and repeated next morning. These lots were prepared for staining. Tried borax carmine, picrolithium carmine and Böhmer's Hæmatoxylin; the last gave the best results.

Spent rest of week in arranging a new kind of filter gate, to be tried the season of 1903.

Sec. 3. Discussion of Special Features and of the Illustrations on Plates I. to VI. and Frontispiece.

THE EARLY DEVELOPMENT OF THE OYSTER EMBRYO. PLATES I. TO III.

The figures were drawn, in nearly all cases, from the living specimens, by the aid of a camera lucida. These sketches were enlarged by pantagraph and have been again reduced by the electrotyper. With two or three exceptions, the figures represent the unmodified original drawings. The exceptions were made up from features in two or three separate studies. I found it unexpectedly difficult to interpret the images shown in the microscope; large special yolk grains make more show than some transparent, yet significant structures. The most difficulty encountered concerned the normality of the development.

Again and again did we keep oyster embryos for more than three days, in which the shell stage failed of development, but the embryos underwent successive changes, that were of teratological nature, or were features of degradation.

So far as our experience went, under temperatures that hovered near 80° F., we may, I think, safely conclude *that if a lot of spawn fails to reach the shell stage by the close of the second day, it will prove to be an abnormal development.*

This is an important conclusion and is a completely revolutionary revelation to our ideas hitherto held. It follows that many of the views shown of embryos are more or less departures from the normal. Here is a splendid field for the study of experimental teratology.

Of course it becomes necessary to ascertain exactly what a normal development is, if we are to make any good progress in the study of the ecology of oyster development.

The figures on Plate I. follow exactly in serial order the last figures of the last plate (VIII.) of our last previous report (1901).

Figure 1 shows the embryo at four hours in optical section, front to back view. At the lower pole are situated two large, yolk-laden cells (macromeres) that are surrounded or capped by a layer of small cells (micromeres). A narrow space (*s.c.*) separates the two sorts of cells. This is the segmentation cavity. The small cells are known as "ectoderm;" the large inner ones are "endoderm."

Figure 2 shows the same embryo, viewed from below. The part of the endoderm left uncovered by the ectoderm is the position where will appear the gastrula mouth (or blastopore).

Figure 3 shows the top view of the same embryo in the beginning of the gastrula stage, at five hours, seen in optical section from above or below. The macromeres have split up into quite a number of endoderm cells.

Figure 4 shows an optical section of the gastrula, viewed from in front. The posterior portion of the embryo is shown in projection shaded. Just in front of this, on the lower part of the figure, it will be noticed that the surface bends up into the mass of endoderm cells, forming a sort of recess, pit or bay. This hollow is the beginning of the gastrula cavity, which will eventually become transformed into the stomach.

Figure 5.—Side view of an embryo in the same stage as Figure 4. The polar globules (*p.g.*) are seen in place; the position of the gastrula invagination is indicated; the broad end (vertically measured) is the future front end of the oyster and faces to the left; the posterior end is actually wider (though narrower vertically) than the front end. The gastrula at this stage is somewhat depressed as a whole.

Figure 6.—The gastrula stage completed at ten hours. The ectoderm, the endoderm and the gastrula cavity, or stomach, are completed. The gastrula mouth (*b*) is now open. It soon closes up.

Figure 7.—Side view of a slightly older embryo at the time it begins to swim, about twelve hours after fertilization. At the front end a circle of cilia has formed, surrounding the polar globules, which, by the superior development in the upper part, just behind, have been pushed more to the front. These cilia become quite long, and by their movement the embryo spins round in the direction indicated by the arrows. The cilia, of course, strike the water most forcibly in the opposite direction. The arrow in front of the figure indicates rotation of the embryo about a transverse axis (one perpendicular to the plane of the page). The other arrow indicates rotation about the longitudinal axis. Soon the entire body becomes covered by a development of shorter and smaller cilia. The gastrula mouth has closed at *s*, where the shell will first appear, while at *m*, on the apparent back of the embryo, is a depression marking the position of the future mouth. Hence, what we have hitherto represented as the back of the embryo is henceforth to be known as the belly, and the subsequent figures are placed with the mouth (or ventral side) lowermost. If Figure 7 be rotated so as to bring *m* on the lower side, the anterior circle of cilia will point to the right, as in Figure 11. In Figure 8 this circle is shown on the left end, but that is because we are

viewing the embryo from the side opposite to that shown in 7. As seen in the microscope, 7 is viewed from the right side, 8 from the left side, and, in general, all the figures with these long cilia (known as velar cilia) on the left end of the figure are left side views; those with the velum pointing to the right (when the belly is downward) are right side views. But it must be remembered that the apparent right side, seen in a compound microscope, is really the left side, because the lenses in this instrument invert the images of objects. To avoid confusion, we treat these images as real and ignore the fact of the inversion.

Figure 8.—Embryo at twenty-three hours, viewed from the left side. The segmentation cavity, which is a sort of body cavity, is shown; also the stomach (*st*), the beginning of the intestine (?), at *i*, and of the "liver," which is a bud from the stomach, at *l*.

Figure 9.—From the right side, a specimen at sixty-eight hours, in a greatly retarded condition of development and partly abnormal. It shows the "shell gland" at *sg*.

Figure 10.—From the left side, at thirty-seven hours. At *m* is apparently forming a mouth, leading by a gullet to the stomach.

Figures 11 and 12 show the presence of special patches of long cilia at *c*.

Plate II.—Figures 13 and 14 are embryos at twenty-three and forty hours, respectively. The latter is belated and probably abnormal. The velar disk (*v*) is covered by a shell-like membrane and lacks cilia; at *f* is a peculiar flagellum (also shown in Figure 16) in place of a mouth.*

Figure 15 is a view of an abnormal embryo from below, somewhat obliquely, to show the graduation of the long velar cilia into the medium-length ventral cilia. This embryo lacked cilia elsewhere.

Figure 17 is a view of an embryo from above, at about forty hours, somewhat abnormal. The shell gland lies transversly across the back.

Figure 18.—At thirty-seven hours; shows the disappearance of cilia in the dorsal region, where the shell will form.

Figures 19 and 20 show the beginning of the shell at *sh*, at the beginning of the second day of development.

Plate III.—Figure 21. An embryo, from the right, at forty hours, showing the marked development of the shell valves, the protruding

* It is just possible that this flagellum represents fused velar cilia, and the velar disk is the shell area, but the position of the shell gland seems to militate against such a view.

velum and the peculiar swelling on the posterior half of the dorsal part of the right valve (same on left, not visible, because hidden).

Figure 22.—View of embryo at forty hours, obliquely from above, to show at *h* the hinge area; very short at the early stage.

Figure 23.—View of embryo at forty hours, directly from above.

Figure 24.—Same embryo as in Figure 23, from right side.

Figure 25.—Same embryo, from left side, and viewed partly from in front and below; at *m* is shown the mouth, just back of the velum. (The presence of the velum in these larvæ causes them to be known as veligers.) Note the short cilia on the edge of the mantle, not lying against the right valve; also the posterior bulging seen on the left valve; that on the other valve hidden from view.

Figure 26.—View of a slightly more advanced veliger than in Figure 25; the first gills (?), perhaps, are visible at *g*. Note the presence of the polar globules on the velar disk, even at this late stage—forty-eight hours.

Figure 27.—A veliger supposed to be sixty-eight hours old, but degenerating.

Figure 28.—A veliger thirty hours old, viewed from below.

Figure 29.—The same from left side.

ENEMIES OF OYSTER FRY. PLATE IV.

Plate IV. shows, in the first six figures, some of the infusors that develop rapidly in the glasses in hot weather and which feed on the embryos.

Figures 1 and 5 are probably the same species of infusor magnified three hundred times.

Figure 3 is probably a young form of Figure 2; probably *amphileptus;* compare *Litonotus; cv*—contractile vacuole, *n*—nucleus, *m*—mouth.

Figure 4 (*a, b, c*).—Three views of an infusor, not identified.

Figure 6.—A remarkable animalcule, with spiral, ciliated ridges on its body and a beak surrounded by a circle of specially developed grasping cilia. In *a* the front of the body is shown extended and the cilia twirling. In *b* the head is retracted and the cilia are grasping (only the two side cilia are shown). The entire circle "grasps" at once and at frequent intervals.

Figure 7.—A tumbler of oyster spawn, after the fry becomes free, swimming, but before the shell is developed. Note how the fry rises to the top of the water, through which they are nearly evenly distributed, but that then they at once descend to the very bottom in peculiar columns. The different individuals travel at different speeds, and so there accumulates (at different levels) a mass or knot on the column, which drops or swims faster than the rest of the column.

Figures 8 and 9.—Oyster fry in the shell stage, thirty and forty hours after fertilization, seen from below. Figure 8 shows the anterior adductor muscle (*am*); also the hinge line (*h*), now quite long, shining through the semi-translucent body.

GREGARINOID PARASITES IN OYSTERS. PLATE V.

Plate V.—Figures 1 and 2. These peculiar parasites develop in the reproductive ducts, and quite a proportion of oysters (about one per-cent.) is thus afflicted. They are but little larger than oyster eggs and about as numerous, so that the oyster looks as if full of spawn. The supposed spawn proves to be Gregarine-like organisms, when viewed microscopically. They develop from spores, one shown at 8. A little later they appear as in 7, then as in 5 and 6. The two arms and "head" develop as shown in 4, 1 and 9. In 9 one of the arms is shown in an extreme length. It becomes detached, as shown in 2 and 3. Figure 10 is an enlarged portion of one of the arms. It is supposed, these arms, when detached, may develop into "nurses." Figure 11 shows a long, much larger nurse, filled with young. Whether this has developed from an arm or by enlargement of a form like 2, 3, we do not know. Forms 2 and 3 are developing peculiar cavities, which may well be brood-chambers for viviparously developing eggs or spores.

Figure 12 (*a* and *b*).—Ventral and dorsal views of a very common infusor in our spawn lots, viz., *Stylonychia* (sp. ?). This infusor has cilia only along the groove leading to the mouth. It has peculiar posterior spines and "crawling" or "running" or "walking," claw-shaped cilia on an elevated disc on the ventral side, along the aforesaid groove.

Figure 13 is probably a *Euplotes,* a near relative of *Stylonychia.*

Figures 14 to 19 are unidentified infusors, common in our oyster experiments. In 16*b* an individual is shown dividing into two new

beings, the common method of reproduction among unicellular organisms.

Plate VI.—Figure 1. *Bacillaria paradoxa,* a wonderful diatom, common in the mud of oyster beds. These organisms are plants, the cells of which are frequently single, but are also as frequently united to each other in chains. Each cell is called a frustrule and has a shell of glass, pierced by rows of pores, through which the plant receives nourishment and through which it in some mysterious manner is able to propel itself steadily backwards and forwards. *B. paradoxa* differs from most other chains of diatom cells, in that while the frustrules adhere to each other, they at the same time can slide or travel lengthwise upon each other; thus a short chain can lengthen itself and zigzag about in a way that must be seen to be appreciated.

Figures 2 and 4.—*Nitschias,* also diatoms; at 5 are two sponge spicules; at 6 is a *vibrio,* a bacterium. A bacterial filament filled with spores is shown at 7. Figure 8 shows one of the low algæ, known as oscillatoria. This is able to bend and slide along slowly; 9 and 10 are also low forms of algæ present in the mud, on which the oyster depends so much for food.

Figure 11 is a house made of cemented grains of sand and is occupied by a rhizopod. Rhizopods are unicellular animals, made up of protoplasm in its simplest form. Such protoplasm can flow or stretch out into long projections, called pseudopods.

Figure 12 is a horny case or house of another species of rhizopod, nearly related to *Difflugia.*

Figure 13 shows six successive views of the same *Amœba* (a naked rhizopod). This species forms many long pseudopods, that are constantly being drawn back into the body and new ones formed in other parts of the body.

Figure 14 shows the outlines of another species of *Amœba* drawn every few seconds.

Figure 15 is a rhizopod, known as *Actinosphærium,* which makes a skeleton of radiating spicules. At *b* is seen two individuals uniting (conjugation), though it may be that we have here only a case of one individual multiplying or reproducing by fission (division.)

Figure 16.—*Euglena viridis,* a unicellular animal (Protozoan), showing a red stigma or "eye" at *e.,* a gullet at *g.,* a *flagellum* (lash) at *c.,* used as an organ of locomotion, and also for prehension of food. At *cv* is the contractile vacuole, a pulsating sac, used for excretory purposes.

Figure 17.—Another *Euglena,* shown in three successive phases of motion. This travels by means of a swelling forming at the front end, which travels backward like a wave, and so, pushing against the water, the animal is shoved forward.

Figures 18, 19 and 20 are three other specimens of flagellated Protozoa.

Figure 21.—Two infusors in conjugation. It is is usual to consider the smaller of the two the male, the larger the female. They are, therefore, respectively, the sperm and egg of this species of animal, which remains all life long in the egg stage, or rather, it segments (divides) after conjugation (fertilization) as does the egg, except the cells do not keep together in one body, but live independently.

FOOD OF THE OYSTER. FRONTISPIECE.

The oyster apparently has to eat all the small organisms that are in the sea water and that become entangled in the slime on its gills. Thus, the different Protoza we have shown on Plate VI. may contribute to this end, or, at any rate, they were found in the material that was being eaten by the oysters. Some of these forms retaliate by eating oyster spawn. About four-fifths of the food of the oyster consists of diatoms. The forms met with in the water on the oyster-beds are shown on our frontispiece plate.

The shell or frustrule of diatoms consists of two glassy valves that fit together like a pill-box and its cover. The top and bottom views are known as "side views;" the side is called the "front" of the frustrule.

When diatoms grow their protoplasm presses the cover valve and the box bottom apart; at the same time a girdle is produced around the line of union of the two valves, which holds the box and bottom together, while the protoplasm separates into two masses, one in the cover valve and one in the bottom valve. Then the mass in the cover secretes a new "bottom" and that in the bottom makes a new cover, and the girdle drops away, releasing the two new-formed diatom cells. In Figure 35 of the frontispiece the two upper diatoms of the chain of four show young girdles, while the parents are still united by the old girdle. The girdle is visible only in a "front" view. Single diatoms usually lie on their "sides," but when produced in chains they show their "front" views.

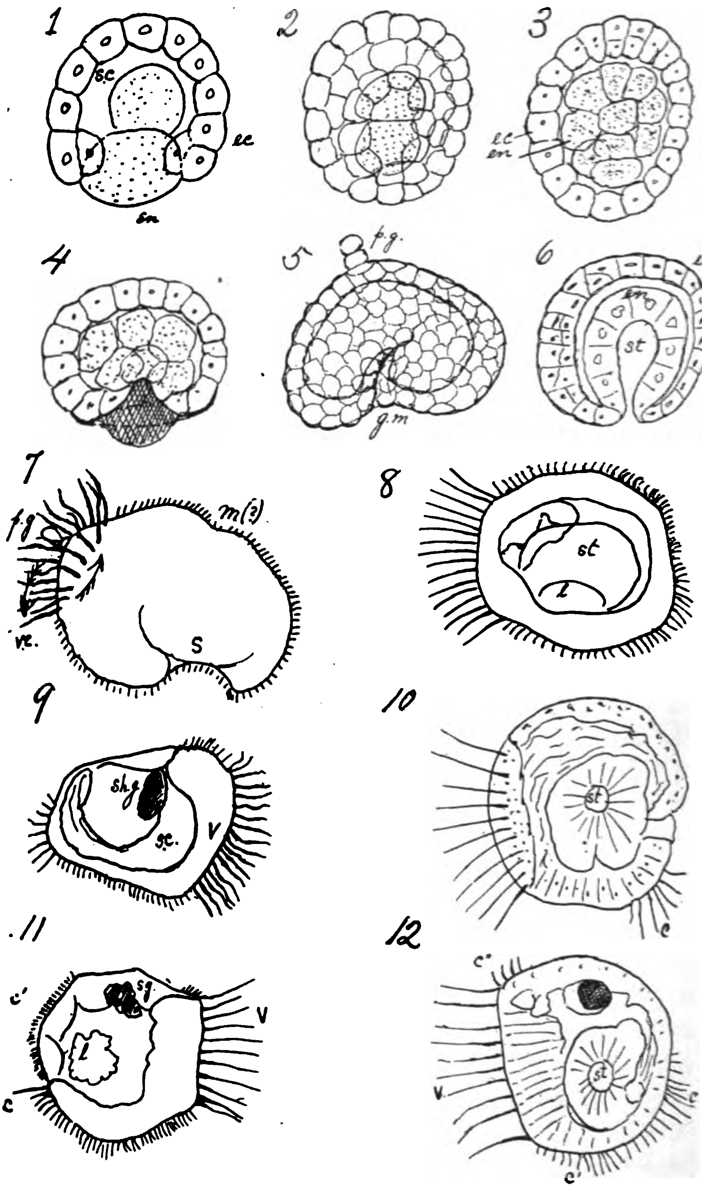
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PLATE I.

EXPLANATION OF PLATE I.

THE FORMATION OF THE GASTRULA.

Figure 1. Oyster larva, from front, 4 hours old. September 2d.
Figure 2. Oyster larva, from below.
Figure 3. Oyster larva, 5 hours old, optical horizontal section.
Figure 4. Oyster larva, 6 hours old, optical transverse section.
Figure 5. Oyster larva, 8 hours old, right side.
Figure 6. Oyster gastrula, 10 hours old, optical transverse section.
Figure 7. Oyster gastrula, 12 hours old, from right side.
Figure 8. Oyster gastrula, 23 hours old, from left side. July 30th.
Figure 9. Abnormal larva, 68 hours old. August 1st.
Figure 10. Larva, 37 hours old, from above. August 29th.
Figure 11. Abnormal larva. Same age and date.
Figure 12. Nearly normal larva, from left side.

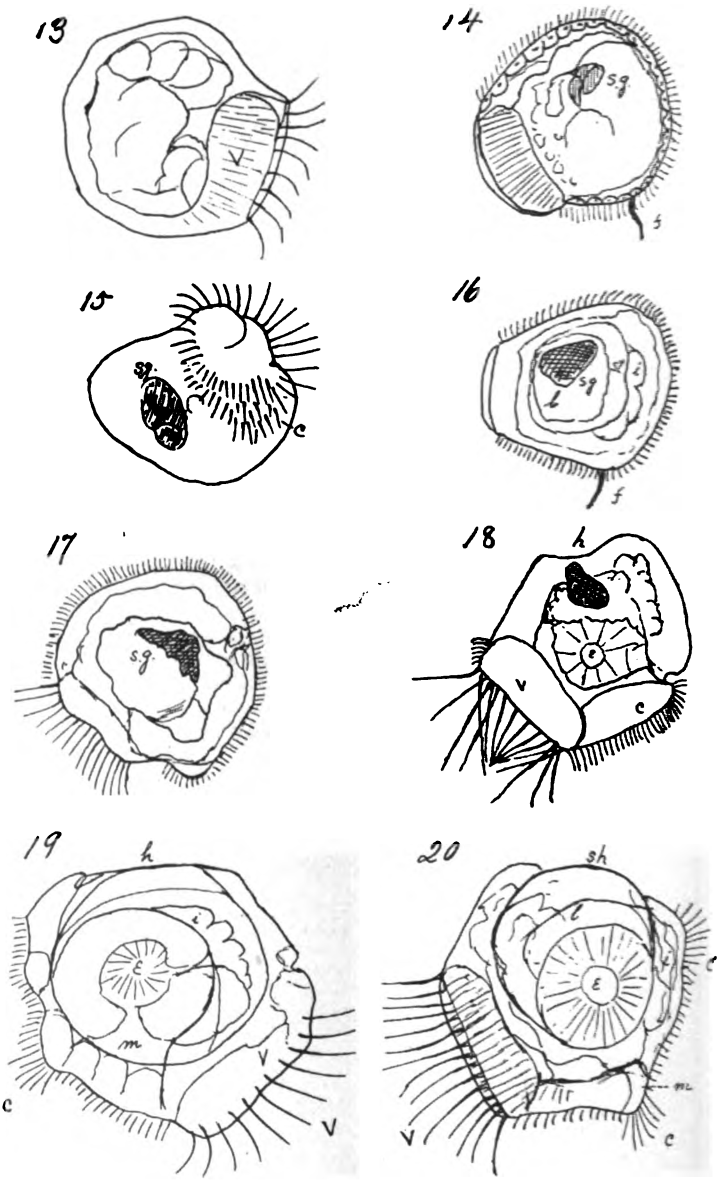


PLATE II.

EXPLANATION OF PLATE II.

THE ORIGIN OF THE SHELL.

Figure 13. Oyster veliger, one day old. July 30th.
Figure 14. Oyster larva, 40 hours old, normal. July 24th.
Figure 15. Another abnormal larva, from ventral side.
Figure 16. An abnormal larva, from left side.
Figure 17. An abnormal larva, obliquely, from above. July 24th.
Figure 18. A nearly normal larva, 37 hours old. August 28th.
Figure 19. A larva about 37 hours old, from right side.
Figure 20. A larva about 37 hours old, from left side. July 31st.

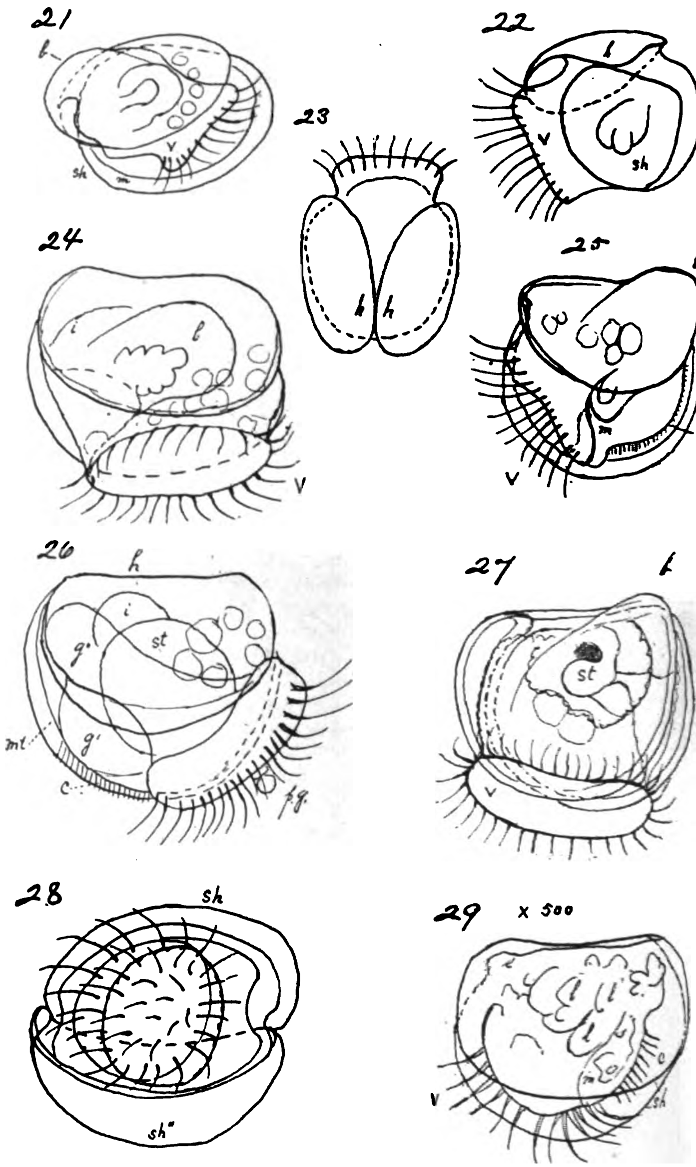


PLATE III.

EXPLANATION OF PLATE III.

COMPLETION OF THE VELIGER.

Figure 21. Oyster fry, 40 hours old, seen obliquely from right side.
Figure 22. Oblique dorsal view of oyster fry, 40 hours old. June 20th.
Figure 23. Dorsal view of oyster fry, 40 hours old.
Figure 24. Oyster fry, same stage from right side.
Figure 25. Oyster fry, same stage, obliquely, from front, left side.
Figure 26. Oyster fry at the beginning of third day.
Figure 27. An older oyster larva, degenerating. August 1st.
Figure 28. Oyster fry, 30 hours old, from ventral side.
Figure 29. Same larva, from the left side. August 6th.

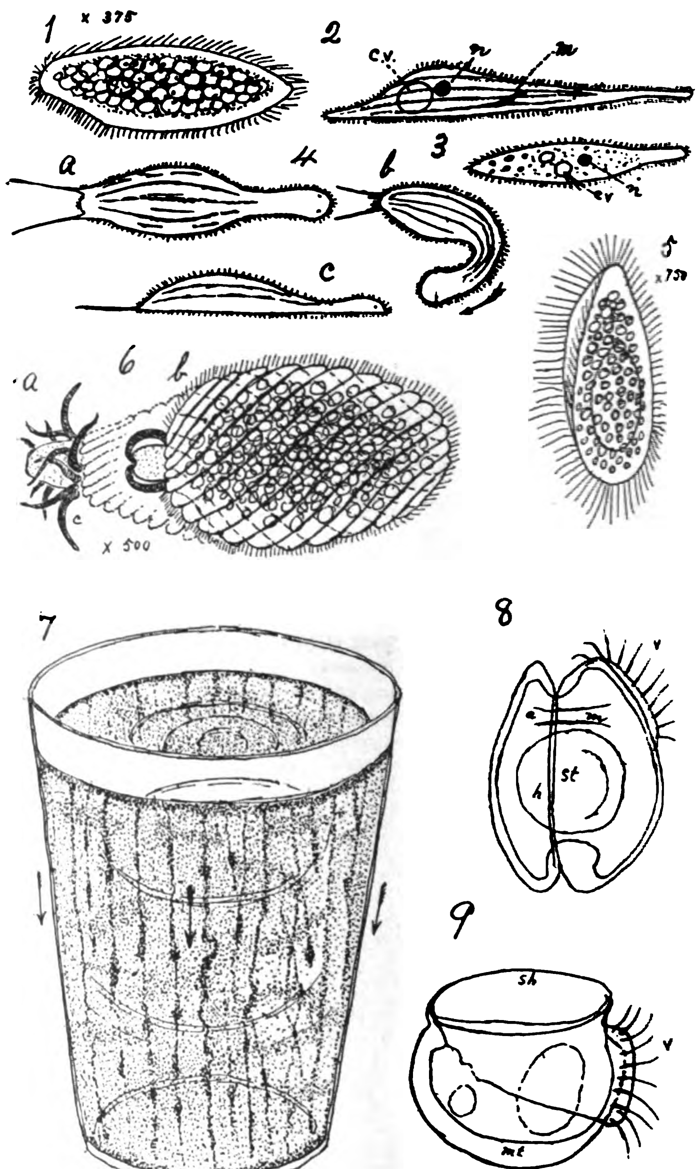
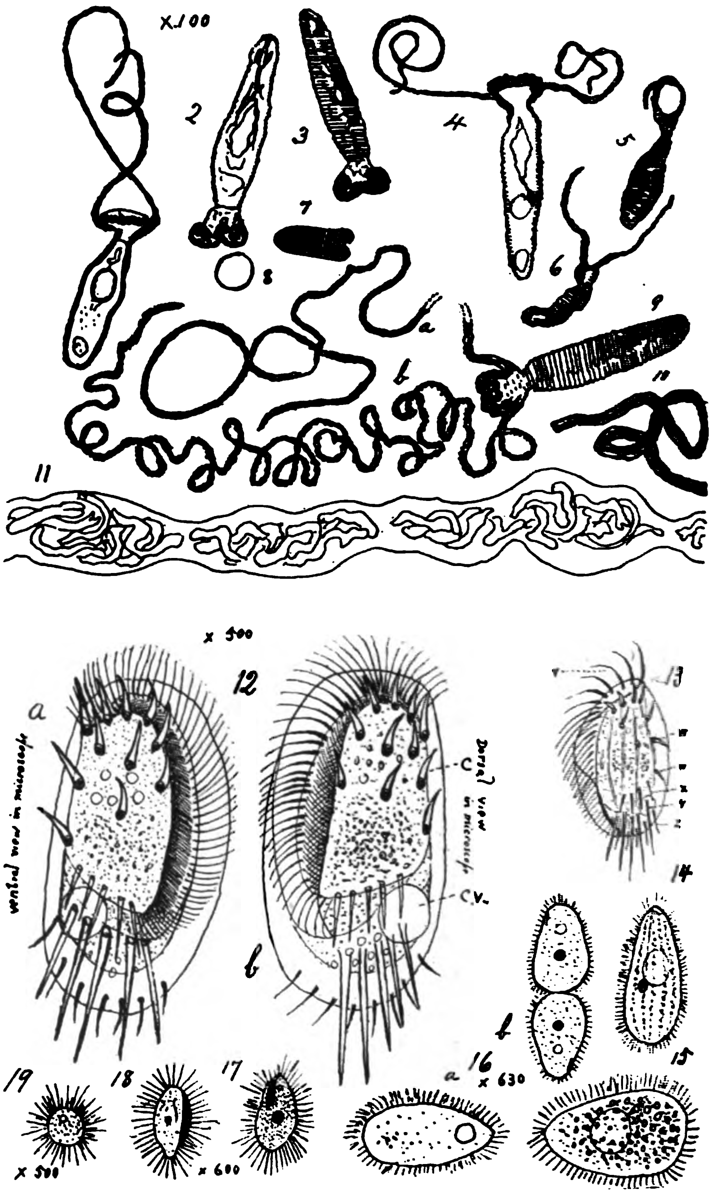


PLATE IV.

EXPLANATION OF PLATE IV.

Figure 1. Infusor sp.
Figures 2, 3. *Amphileptus* (?)
Figure 4. Unidentified infusor.
Figure 5. Same as 1.
Figure 6. Unidentified animalcule.
Figure 7. Tumbler of oyster fry, one day old; arrows show direction of travel of columns.
Figure 8. Ventral view of oyster fry, nearly two days old.
Figure 9. Oblique ventral view of oyster fry, nearly two days old.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b
x 500
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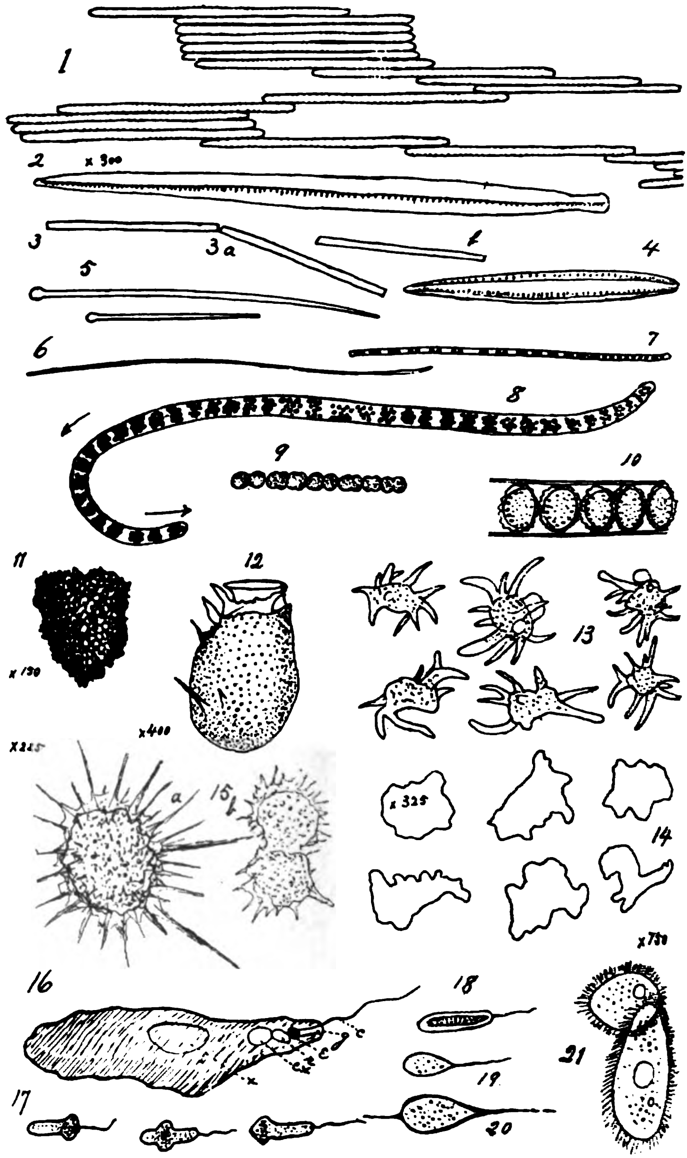
b
ventral view in microscope
Dorsal view in microscope
C
C.V.
13
14
15
16
x 630
17
18
19
x 500
x 600

PLATE V.

EXPLANATION OF PLATE V.

MICROSCOPIC PARASITES AND ENEMIES OF OYSTERS.

Figures 1 to 11. Gregarinoid parasites of oysters.
Figure 12, *Stylonychia* sp.
Figure 13. *Euplotes* (?)
Figures 14 to 19. Ciliated infusoria.
Figure 16*b*. Reproduction by fission.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x 225
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x 325
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x 750
16
18
19
21
17
20

PLATE VI.

EXPLANATION OF PLATE VI.

ORGANISMS PRESENT IN OYSTER FOOD.*

Figure 1. *Bacillaria paradoxa.*
Figure 2. *Nitschia* sp.
Figure 3. *Diatoma* (?).
Figure 4. *Nitschia* sp.
Figure 5. Sponge spicules.
Figure 6. Vibrion.
Figure 7. *Sporulating bacillus.*
Figure 8. Unidentified motile alga.
Figures 9, 10. Alga sp.
Figure 11. Arenaceous rhizopod (*Difflugia*).
Figure 12. Rhizopod, with siliceous shell.
Figure 13. *Amœba proteus.*
Figure 14. *Amœba* sp.
Figure 15. *Actinosphærium.*
Figure 16. *Euglena viridis.*
Figure 17. *Euglena* sp.
Figures 18, 19, 20. Flagellated infusors.
Figure 21. Conjugation of ciliated infusors.

*The principal diatom constituents of oyster food are shown on the frontispiece plate.
NOTE.—All the illustrations in this Oyster report were drawn from nature by the author.

PART II.

OBSERVATIONS ON ABORTION AND TUBERCULOSIS IN CATTLE.

As nearly all the available time of the Biologist has been occupied in studies bearing on oyster culture, the second part of our report will be brief.

We offer simply the records of abortions and cow temperatures at the tests for admission into the College Farm herd, furnished by C. B. Lane, Assistant in Dairy Husbandry, of the Station. And also the autopsies of the last survivors of the experimental herd from the tuberculosis hospital, slaughtered last March.

Nothing has been discovered that would change any of the general conclusions published by the writer in previous reports on tuberculosis. The cows that were slaughtered had been sick from tuberculosis for years, two of them since 1895. And about twenty injections of tuberculin had been made without apparently affecting the slow course of the disease. It is not denied that these repeated testings may have delayed the development of the disease. Quite apparently they did not hasten it. Reactions were present in some of the tests only, but absent in most of them.

*Record of Abortions in College Herd, November, 1901—November, 1902.

COWS.	Stall.	Age—years.	Date of purchase.	Date of service.	Date of abortion.	Months of pregnancy.	Previous service of bull. Cow.	Previous service of bull. Date.	Vitality of calf.
Regena, 3d.	26	4	Raised.	Aug. 27, 1901.	May 22, 1902.	$8\frac{25}{30}$	No. 11.	Aug. 10, 1901.	Dead.
Princess (sixth time)	30	6	Sept. 22, 1896.	Sept. 17, 1901.	May 22, 1902.	$8\frac{5}{30}$	Buttercup.	Sept. 11, 1901.	Alive; died.
Lilith	4	5	Sept. 18, 1901.	Nov. 2, 1901.	July 19, 1902.	$8\frac{17}{30}$	No. 21.	Oct. 26, 1901.	Alive; died.
†Elixir's Beauty	30	6	Raised.	Nov. 14, 1901.	Mar. 14, 1902.	4	Sebolt, 2d.	Nov. 11, 1901.	Dead.
†Elixir's Jilix	New wing.	2	Raised.	Mar. 4, 1902.	July 6, 1902.	4	30-2d.	Feb. 27, 1902.	Dead.
Diana	7	7	Nov. 4, 1901.	Mar. 7, 1902.	Oct. 9, 1902.	7	Regena.	Dec. 28, 1901.	Dead.

*By C. B. Lane.

†Daughters of Elixir, who aborted August, 1901.

AUTOPSY OF NO. 15. MARCH 31ST, 1902.

This animal, a Guernsey heifer, was tested by tuberculin injection March 11th, 1898, on admission to the College Farm herd. Its highest temperature before injection was 101.7° F.; after injection, the temperature rose to 106.6°, a very evident case of tuberculosis, and the animal was transferred to the hospital barn, being added to the tuberculous herd quarantined in that place. The following November the cow was tested the second time, the temperature rising from 101.8° to 104.6°, still an evident reaction, though smaller than on the first test.

January 4th, 1899, she was tested the third time, but the temperature record the day following the injection of the tuberculin was much lower than on the previous day and so it was declared that no reaction had occurred.

On November 5th, 1900, the cow was tested the fourth time, when her temperature maxima were 102.5° and 104.7°, respectively, somewhat of a "reaction."

On June 15th, 1901, she was tested the fifth time, but failed to show a reaction. Finally, on March 31st, 1902, she was slaughtered, and, on the dorsal margins of the two posterior lobes of her right lung, we found several clusters of small tubercles imbedded in the lung substance.

There was also a small connective tissue nodule on the liver and an irregular tubercle on the small intestine containing soft, greenish contents. Evidently she was not badly affected, and when we consider that she had been diseased for at least four years, but cannot tell whether the disease had progressed or not during this period, we must conclude that in her case either the disease was stationary or that she gave the first tremendous reaction when only incipiently affected. The question arises, did the repeated testings have any effect in retarding the disease? To answer such a query we would need a protracted series of experiments on a large herd of tuberculous animals, dividing it into two lots, one of which received treatment and the other not. Evidently, as regards No. 15, any answer would be pure guesswork.

AUTOPSY OF NO. 14. MARCH 31ST, 1902.

This was one of the original members of the hospital barn experimental herd for studying tuberculosis. Her first injection occurred at the opening of the year 1894. She showed no reaction until nearly two years later, on her sixth test. After that, reaction was shown on the tenth, thirteenth, fourteenth, eighteenth and twentieth tests, the last test, the twenty-first, June 15th, 1901, being without effect. She had therefore been diseased for seven or eight years. Physical examination in 1897 by Dr. G. F. Harker revealed "mucous râles in the dorsal portion of both lungs."

This animal was chosen as part of the hospital herd only as the result of the sixth injection in 1895. Her disease seemed to very slowly progress, but whether the injections did retard this progress or not cannot be told.

The autopsy, March 31st, 1902, revealed the presence of a large, encysted pus cavity in the posterior lobe of the left lung. In the liver was found a small, encysted tubercle with a soft center. The mediastinum was much thickened and there was an excessive growth of connective tissue surrounding the roots of the lungs. The surface of the serous membranes lining the pleural and abdominal cavities, including both surfaces of the diaphragm, were roughened and covered with a rash-like eruption. Her kidneys were enlarged and the walls of the heart were extraordinarily thin. Evidently, there was present a complication of diseases, dependent on general constitutional weakness.

AUTOPSY OF NO. 72. MARCH 31ST, 1902.

This large cow was the first and the last of the old veterans of the hospital herd. It had been tested nineteen times and given very marked reactions on the second and sixteenth injections. No reactions were present on the first, fourth, fifth, sixth, seventh, ninth, tenth, twelfth, fourteenth, fifteenth, seventeenth, eighteenth and final tests.

Autopsy showed the presence of genuine and quite extensive tubercles, but all evidences of the disease showed it to be confined to the lungs, the left worse than the right, and the posterior lobes worse than the anterior ones, about whose bronchial roots the tubercles clustered, buried in the lung tissue.

*Tuberculin Tests of Additions to College Farm Herd—1902.

Cows	Diana.		Jersey, No. 18.		Guernsey, No. 19.		† Buttercup.		Woodlawn.		Roma, 2d.		Myrtle.		Yolland.		Alta, 2d.	
Dates	Dec., 1901, 2d and 3d		Dec., 1901, 17th and 18th.		Dec., 1901, 17th and 18th.		Jan., 1902, 21st and 22d.		Sept., 1902, 12th and 13th.		Sept., 1902, 12th and 13th.		Sept., 1902, 12th and 13th.		Oct., 1902, 17th and 18th.		Oct., 1902, 17th and 18th.	
5 A. M.		101.5		101.6		101.0				101.1		101.1		102.4				
6 "		101.5								101.2		100.8		102.0		100.8		101.3
7 "		101.8								101.0		100.8		101.6				
8 "		102.8		101.7		100.5				101.3		101.0		101.4		101.2		101.5
9 "		101.6		101.7		100.6	101.7	101.4		101.1		100.5		101.1				
10 "		101.7		101.8		100.7	102.0	101.6		101.2		100.7		101.3		101.3		101.6
11 "		101.4		101.8		100.7	102.2	101.5		101.7		101.0		101.6				
12 M.		101.6		101.9		100.8				101.5		100.9		101.6		101.4		101.7
1 P. M.		101.7		101.9		101.0				101.5		101.8		101.6				
2 "		101.8		101.8		101.0	102.4	102.0		101.5		161.1		101.4		101.0		101.4
3 "		101.5		102.1		101.0	102.0	101.8		101.6		100.8		101.6				
4 "	101.7	101.6		102.1		101.0	102.0	102.0		101.7		101.4		101.9	101.8	101.8	101.9	102.2
5 "	101.8	101.7	101.8	101.9	101.6	101.2			101.9	101.6	101.6	101.0	102.0	101.8				
(5:30) P. M.									(Inj.)		(Inj.)		(Inj.)					
6 P. M.	101.8	101.9	101.8	102.2	101.7	101.6			102.4		101.8		102.6		102.0	101.7	101.9	102.4
															(Inj.)		(Inj.)	
7 "	101.4		101.6		101.6				102.5		101.8		102.3					
8 "	101.6		101.5		101.3				102.8		101.2		102.2		101.3		101.0	
9 "	101.3		101.3		101.5				102.7		101.6		101.7					
10 "	101.7		101.3		101.4				102.4		101.1		102.1		101.4		101.2	

* By C. B. Lane.

† Not injected.

REPORT OF BOTANIST.

REPORT OF THE BOTANIST.

BYRON D. HALSTED, D.Sc.

JAMES A. KELSEY, M.Sc., FIELD ASSISTANT.

For the year ending November 30th, 1902, the work in the Botanical Department has been chiefly confined to experiments in the greenhouse for the winter and upon the Experiment Area during the growing season.

Owing to an enforced absence by the head of the department on account of personal illness, the field work has been in charge of Mr. J. A. Kelsey, field assistant for several years past.

Attention has been given chiefly to the breeding of truck crops, with some supplemental lines, extending into variety testing and the development of new sorts of ornamental plants.

The cross between the "Henderson" and "Burpee" dwarf lima beans has occupied considerable space, and the work of fixing the variety by selection has been in progress. Some of the reversions to the pole type have been grown and the results indicate something of value.

The cross between the "Long Purple" and "New York Improved" eggplant has been propagated largely, showing for the second year, as anticipated, considerable variation from the first type, with a tendency to go toward the "New York Improved" parent. Here selection is needed to fix the characteristics and develop a sort that is truly spineless.

The work in crossing tomatoes has gone on, and there is substantial hope of obtaining a sort that will be comparatively seedless, with remarkable vigor and uprightness of vines.

Several plots have been in crossed sweet corn, and, after four years, a combination of the "Black Mexican" and "Egyptian" is becoming established, combining the qualities of the parents in a pink variety. Some points in plant breeding have appeared in connection with the work with the corn, notably a weakness shown in albinism in connection with the in-an-in breeding.

A recent cross between the hot-house "Telegraph" cucumber, remarkable for its great length and seedlessness, and the celebrated "Znaim" variety, grown largely as a field crop in Austria, may prove of value. The work of breeding for a smooth (spineless) fruit is also progressing.

The work with a hybrid salsify is going on. Great variation is noted in vigor of plants, colors of blooms, etc., but the quality of the roots has not yet been tested.

Testing of some new importations of plants has been made.

Some of the above-mentioned lines of work were carried on in the greenhouse, and others in connection with the Experiment Area. One of the leading features of the work under glass was the testing of fungicides for a powdery mildew that is often destructive to greenhouse plants. It was found that a kerosene emulsion was a very effective remedy. It still remains to determine the most economical method of application. A study of the conditions favoring the growth of indoor mildews is needed, that rational preventive measures other than the use of fungicides may be employed.

The work with dimorphism in buckwheat was continued; also some experiments with dodders and other parasitic plants, as broom rape.

Observations as to the prevalence of the asparagus rust have been made, and, by correspondenee with other station workers, some additional facts as to its habits have been obtained.

The Station herbarium has had the usual accessions from various sources during the year.

The Experiment Area.

The plan (Figure 1) upon the opposite page shows the method of plotting the Experiment Area, consisting of two acres, at the College Farm. This plan also locates the several crops that have occupied the ground during the present season.

The seven series, numbered at the top of the plan, extend up and down the slight incline of the field and are separated by four-foot paths, while the four plots, 33 by 66 feet in each series, extend right and left upon the plotted page.* Each plot is further divided the shorter way into six belts, 11 by 33 feet, as shown in the upper plot of Series 0.

* The plan in its full details is given in the report for 1894, page 279.

The Experiment Area.

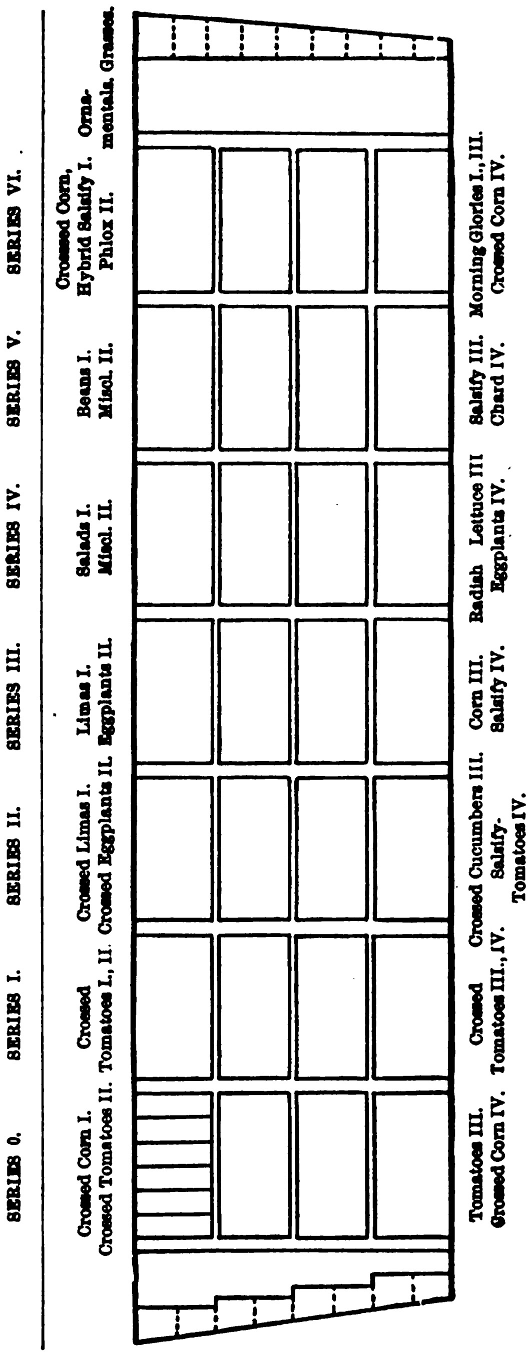


Fig. 1. The Experiment Area in 1902.

The soil, naturally gravelly clay, underlaid with yellow gravel, has been gradually improved by the addition of stable manure at the rate of twenty tons per acre for the past eight years. No other fertilizer has been used. During the winter the land has either lain bare or carried a green cover, produced by sowing rye or barley in the autumn. A special point has been made to clear up the soil after each crop and cart away and burn the refuse. The comparative freedom from disease, especially where the same crop has been grown successively upon a plot, is ascribed to this sanitary method, and is highly recommended to all engaged in growing truck crops.

EXPERIMENTS IN CROSSING SWEET CORN.

Plot IV., Series VI., was again planted with sweet corn. In belts 1 and 2 the seed used was from ears grown in the greenhouse the previous winter. These ears were from seed taken from a solid red ear, named "Extra" (X.), grown in 1901 upon the plot now under consideration. The remaining four belts were planted with grains from the ear "X.," above mentioned, and therefore, while the whole plot was planted with the product of the same ear, the first two belts bore plants one generation further from the original cross of the "Black Mexican" and the "Egyptian." In the tests for albinism (white seedlings) and other characteristics of germination, the ear in question was named "Extra" because it produced first-class plants and gave no signs of albinism.

Unlike the crop of the previous year, the plants were not large and matured more quickly than upon some of the other plots. The two belts planted with the greenhouse-grown seed produced smaller plants than the other four belts, and this was to be expected, because the plants grown in the winter under glass were slender and produced ears of only two or three inches in length, but with nearly normal diameter. The individual grains were of practically the same size as that of their parent. While the stalks in the field were below normal size, the ears were not far below those of the adjoining belts.

The first thing to be observed in the product of the two belts planted with the greenhouse-grown corn is the large number of red grains. The table below gives the number of each grains for each color for five average ears:

	Uncolored.	Black.	Red.
No. 1	15	0	365
" 2	0	0	420
" 3	36	0	360
" 4	0	0	340
" 5	20	0	380
Average	14	0	373

A similar count made for previous crop upon the same land gave—

	Uncolored.	Black.	Red.
Average 1900	172	121	92
" 1901	90	81	261

This shows that the number of red grains has greatly increased, while the white and dark grains have correspondingly decreased as a natural consequence.

The ears, while agreeing in being very nearly all red, show many differences, particularly in the number of rows of grains, and somewhat in the intensity of the red, it varying from a light pink to a dark purple. This latter variation may be in the same ear, or, upon the other hand, an ear may be solid of any one of the many shades of red.

The original red ear, "X.," was ten-rowed, those of its greenhouse progeny were ten, and the following table gives the field crop descended therefrom:

Number of 8-rowed ears	3
" " 10 " "	10
" " 12 " "	42
" " 14 " "	15
" " 16 " "	6

Belts 3, 4, 5 and 6 were planted with grains from ear "X.," above mentioned. As before stated, the plants were not quite normal size, which may be explained by the situation of the plot and peculiarities of the season. It remains to be shown whether the size and earliness are varietal peculiarities.

The following table gives the number of grains of each color for five average ears:

	Uncolored.	Black.	Red.
No. 1	60	0	444
" 2	0	0	420
" 3	10	0	560
" 4	72	0	432
" 5	0	0	480
Average	28	0	465

This is not so much of a gain in red grains as shown for the ears from the greenhouse-grown plants. This is explained above by the fact that these belts grew a crop one generation nearer to the original cross than the adjoining two belts. The greater number of grains per ear shows that upon the same plot the greenhouse-grown plants produce smaller ears than those raised in the field.

Something of the character of the ears may be gained from the following table:

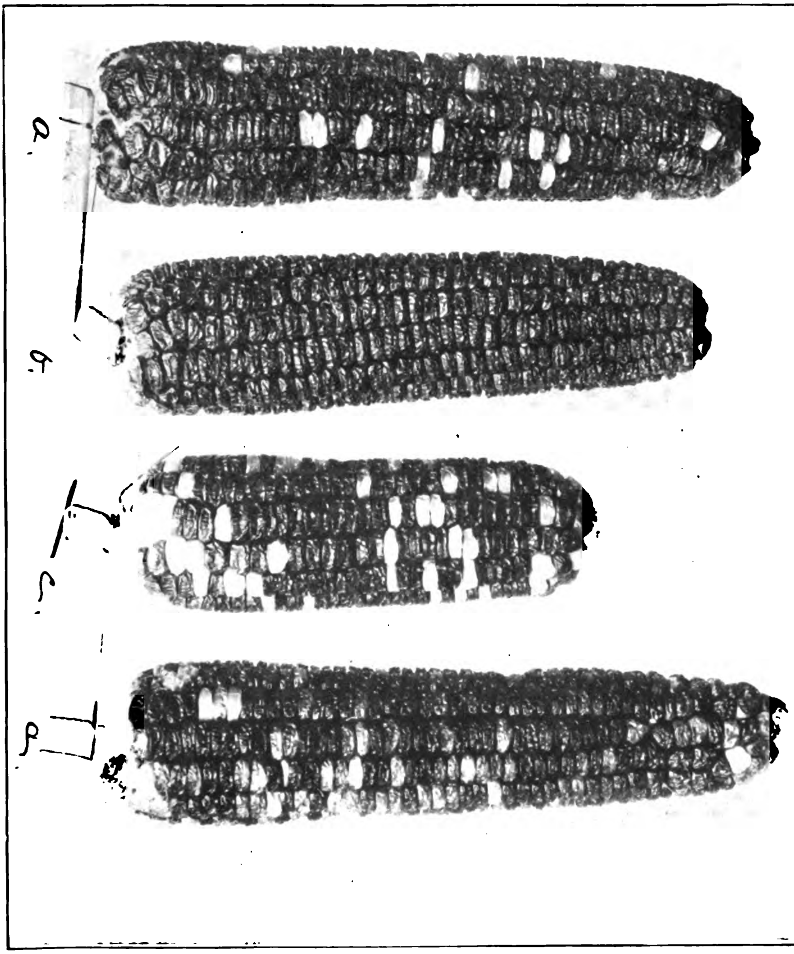
Number of 8-rowed ears	6
" " 10 " "	15
" " 12 " "	38
" " 14 " "	14
" " 16 " "	6

Plate I. shows four ears from the above lot of corn. The one upon the left is untreated; the next to the right is from the greenhouse-grown seed; the next ear was close-fertilized, and the one upon the right was cross-fertilized. It remains to be seen what the relative vitality of the grains from these ears may be.

Selecting Corn for Prolificness.

The work of selecting corn for prolificness was continued the present season. Plate II. shows the two stalks that were selected in September, 1900, as the beginning of this work. One stalk is standing in its place in the plot (IV., series VI.), and another, with triple ears, is placed by its side for the photograph. It may be seen that the six ears are all evenly mixed with the dark and light grains. One stalk bore ears with eight, ten and twelve rows, respectively, and the other, ten, twelve and fourteen ears, respectively.

Samples of the results of 1901 are shown in Plate III., and the results of this selection are given upon pages 407 and 408, in the report for last year.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b.
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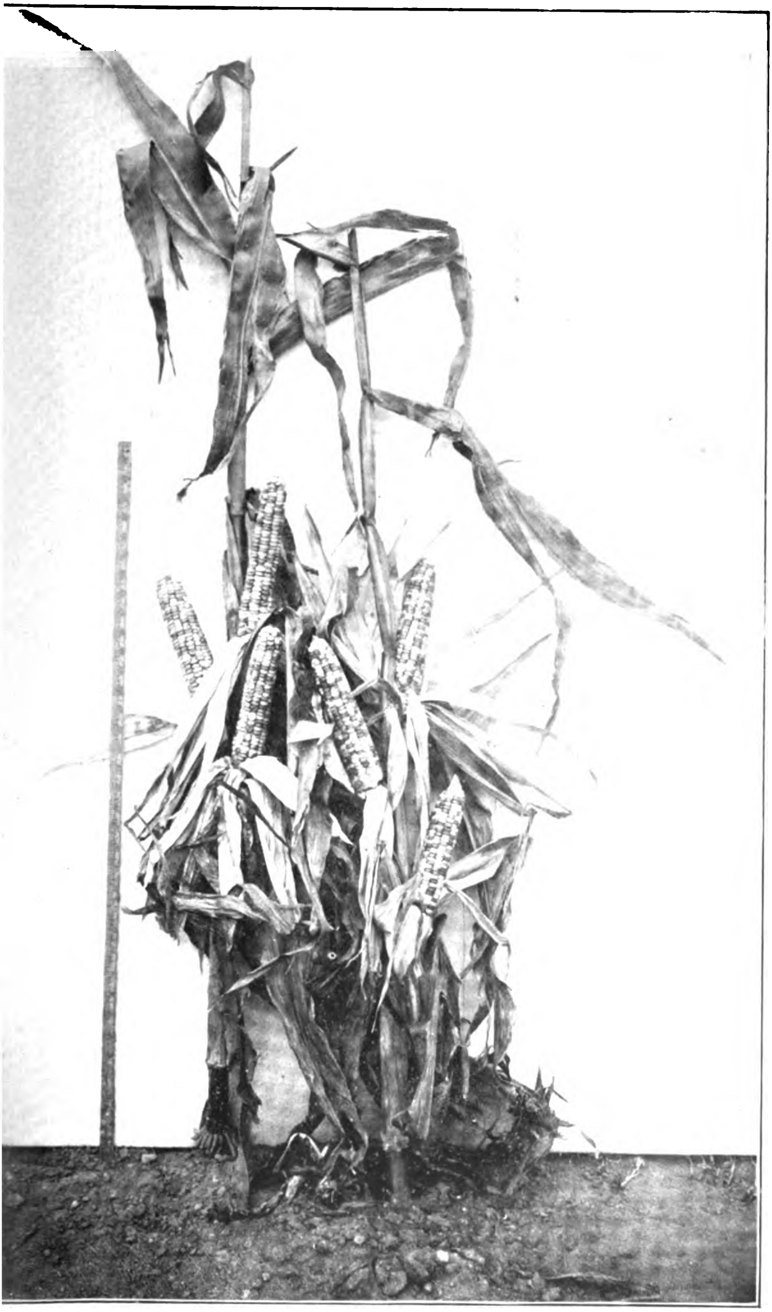

PLATE II.

olific Corn selected for seed from the crop of crossed "Black Mexican" and "Egyptian" in 1900.

PLATE III.

mples of Prolific Corn selected for seed from the crop of Crossed "Black Mexican" and "Egyptian" in 1901.

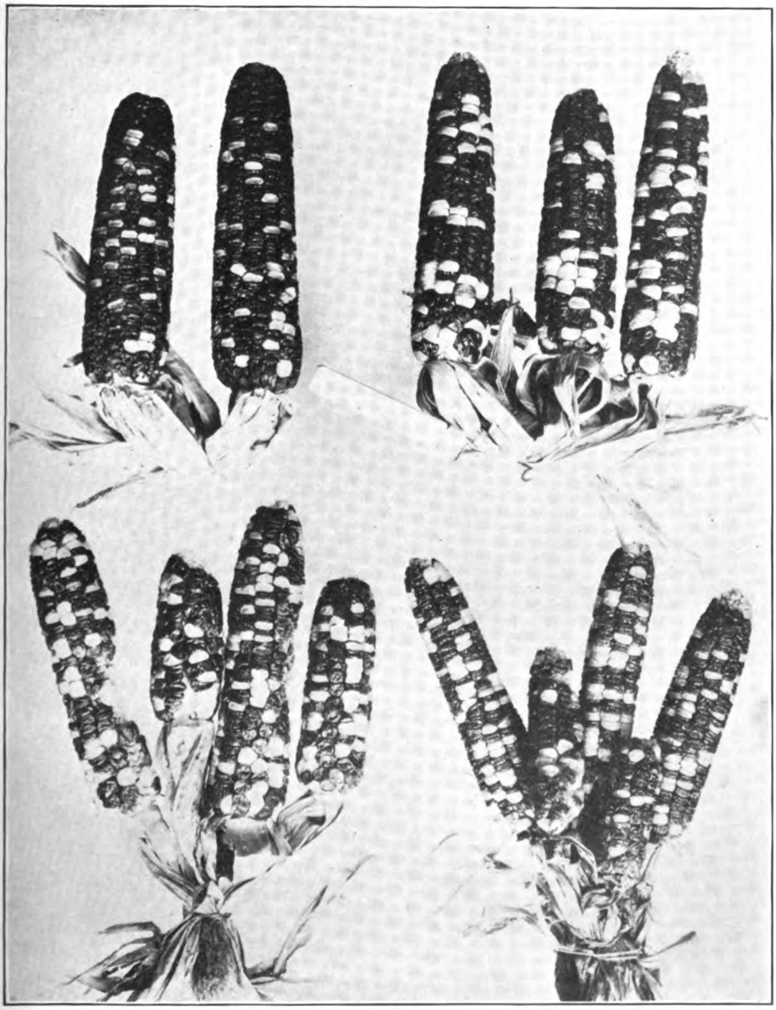

PLATE IV.
Samples of Prolific Corn of the crop of 1902.

During the present year a plot was given to a further study of the increase in yield of corn by selection. Plate IV. gives samples of the result. The corn of this plot was unusually large and vigorous. Single-eared stalks were rarely met with, the main portion having either two or three ears to each plant. There were numerous stalks with four and several with five ears. It is probable that the triplets will be selected for seed as the tendency to ear may be overdone. As two ears are better than one, when both are good, so three good ears are better than a large number, when the quality decreases.

The three plates show that the mixture of black and white grains is maintained without much change. The plan is to keep the two colors and let this breed, if established, be a mixed prolific.

EXPERIMENTS WITH EGGPLANTS.

Crossed Stock.

The crossed eggplants occupied Plot II., Series II., and Plot II., Series III. They were the representatives of four crossed fruits selected from the crop of 1901. Seeds were sown March 1st, and plants set in the field May 20th, three rows to a belt, eighteen plants in a row.

There seemed to be no practical difference between the crossed stock and the parent varieties as to the time of bloom or earliness of fruit; no such contrast as was remarked the preceding season.

A comparative record of the number of fruits produced by a parent and crossed stock was not kept, but the latter seemed to be fully as productive in 1901. Towards the close of the season the parent sorts ceased blooming, while the crossed were covered with flowers and young fruits up to the time of frost.

The plants received but two applications of soda-Bordeaux early in the season and so were practically unsprayed. The foliage was but lightly infested by the leaf blight, while the fruits, in common with those of the standard varieties, suffered severely.

In order to make the spraying of eggplants worth while, the applications during the fruiting season should be frequent—at least once in ten days, and oftener in case of washing rains. Perhaps of more importance than spraying is the careful removal of all fruits as soon as they are of marketable size, or of any smaller spotted fruits.

The shape of the crossed eggplant fruits seemed to be much the same as in the crop of 1901; not over 10 per cent. of the plants produced fruits strongly resembling the "N. Y. Improved" type, the remainder adhering closely to the "Combined" type of first season's crop.

A number of flowers were fertilized with pollen from the Early Long Purple this season, and the seeds of their fruits, together with seeds from others most nearly approaching the form desired, have been saved for further trials.

Variety Tests.

In Plot IV., Series IV., eighteen rows of eggplants were set, each row representing one of the following varieties:

Row 1. New York Improved Large Purple (Burpee).
" 2 Improved N. Y. Purple (Thorburn).
" 3. New Jersey Improved Long Purple (B.).
" 4. Fordhook Improved Spineless (B.).
" 5. Early Long Purple (B.).
" 6. Long Purple (Th).
" 7. Early Dwarf Round Purple (B).
" 8. Early Dwarf Purple (Th).
" 9. Black Pekin (Th.).
" 10. Round French (Th.).
" 11. Delicatesse (Th).
" 12. Black Snake (Th.).
" 13. Striped (Th.).
" 14. White Pearl (B).
" 15. Mammoth Pearl (Th.).
" 16. Round White (Th.).
" 17. Long White (Th.).
" 18. Burpee's Black Beauty (B.).

Probably the above list of eighteen is scarcely representative of eleven distinct varieties. There seemed to be no appreciable difference between Nos. 1, 2, 3 and 4. Plants of Burpee's "Black Beauty" (No. 18) were not secured until late in the season, so that only two fruits were obtained. These were of much the same shape as the "N. Y. Improved" type, except that both were rendered decidedly irregular by a sort of lateral outgrowth. In color they were noticeably darker than the latter.

os. 15 and 16 appeared alike, and differed from the "N. Y. Im-ved" type chiefly in color, and, when cooked, could be scarcely dis-uished from that variety. The "Black Pekin" is smaller (one-d or one-half) and almost round, while the "N. Y. Improved" is in form and of a lighter purple. The "Round French" is some-re between the "Black Pekin" and "N. Y. Improved."

'he "Dwarf Round Purple" sorts (Nos. 7 and 8) were alike, with ts small and of good quality. The "Delicatesse" (No 11) appears s very similar to the "Dwarf Round Purple." The "Long Purple" ety of Burpee and that of Thorburn seemed the same. The fruit he "Snake" (No. 12) was long and very slender; worthless for king. The "Striped" was of an oval shape and about the size of "Round Purple." The "Round White" is about the size of a hen's ; quite ornamental; only of fair quality. The "Long White" is at half as large as the "Early Long Purple;" usually curved.

EXPERIMENTS WITH TOMATOES.

'he usual amount of space in the Experiment Area has been de-ed to tomatoes. The chief work has been in developing the crosses t have been described in previous reports. Further progress has n made toward a type of vine of remarkable vigor and fruit, in ch the seeds are much reduced. This portion of the work was y illustrated in the record of last year. Much difficulty is expe-iced in getting a combination of yellow and red color that yields lush, and, when obtained, to have it regularly reproduced in the pring.

OBSERVATIONS UPON SALSIFY HYBRIDS.

'he third-generation plants in Half-plot I., Series VI., were from -sown seed. Owing to their great number and irregularity, a com-e color record was scarcely possible, but frequent observations were le so long as flowers were produced, and it is thought that practi-y all the different shades were noted and that those occurring most quently are indicated in the following table:

	Color Chart Number.	Color.	Number of Plants.
	21	Darker red red orange	4
	22	Dark red red orange (center yellow)	2
	22	" " " " (center mottled)	5
	31	Darker red orange (center yellow)	1
	41	Darker orange red orange	1
	32	Dark yellow yellow orange	2
Parent type	93	Yellow	107
	94	Light yellow	1
	95	Lighter yellow	1
Parent type	224	Light violet red violet	150
	224	" " " " (center light)	27
	225	Lighter violet red violet	12
	233	Red violet	13
	233	" " (center yellow)	2
	233	" " (center mottled)	1
	234	Light red violet	12
	234	" " " (center yellow)	10
	234	" " " (center mottled)	6
	234	" " " (center drab)	8
	242	Dark red red violet	11
	242	" " " " (center yellow)	2
	242	" " " " (center mottled)	4
	243	Red red violet	27
	243	" " " (center yellow)	34
	243	" " " (center mottled)	30
	333	Red gray or russet	7
	333	" " " (center yellow)	14
	333	" " "	12
	334		2
	334	(center yellow	1
	355	Lighter yellow gray	7

The second-generation plants, grown in Half-plot IV., Series II., were the offsprings of twelve hybrids produced by crossing *Tragapogon porrifolius* L. with *Tragapogon pratensis* L. The greater part of the sowing consisted of a mixture of the seed of these twelve hybrids. Small portions of the seed of eleven plants were reserved, however, and each sowed by itself. The color of each parent plant and that of its offspring are indicated below:

Color Chart Number.		Color.	Number of Plants.
21		................(center yellow)..	..
	233	Red violet (center yellow).	1
	243	Light red violet (center yellow)....................................	1
32		........................(center yellow)................................	..
	22	Dark red red orange..	1
	25	....	1
	93	Yellow..	1
	225	Lighter violet red violet (center light)..........................	1
	233	Red violet..	2
	234	Light red violet..	1
	235	Lighter red violet..	1
	242	Dark red red violet..	2
	243	Red red violet..	10
	243	" " " (center yellow)..	12
	333	Red gray or russet (center yellow)...............................	6
51		....	..
	333	Red gray or russet (center yellow)...............................	1
94		Light yellow..	..
	93	Yellow..	2
	243	Red red violet..	1
95		Lighter yellow...	..
	31	Darker red orange (center yellow)................................	2
	93	Yellow..	8
	95	Lighter yellow...	1
	234	Light red violet (center light)....................................	1
	333	Red gray or russet..	1
	334	....	1
	354	Light yellow gray...	1
223		Violet red violet..	..
	225	Lighter violet red violet (center light)..........................	1
	233	Red violet..	1
	233	" " (center light)...	1
233		Red violet..	..
	233	Red violet..	1
	243	Red red violet..	1
238		Red violet..	1
	233	Red violet..	1
	234	Light red violet..	1
	243	Red red violet..	2
	243	" " " (center mottled)...	4
384		Light violet gray..	..
	234	Light red violet (center light)....................................	1
	243	Red red violet..	2

Below is given the number of plants of different shades resulting from the mixed lot of seed:

Color chart Number.	Color.	Number of Plants.
22	Dark red red orange (center mottled)	2
31	Darker red orange	1
31	" " " (center yellow)	6
41	Darker orange red orange (center yellow)	4
93	Yellow	150
223	Violet red violet	1
224	Light violet red violet	140
224	" " " " (center light)	9
225	Lighter violet red violet	1
225	" " " " (center drab)	17
233	Red violet	7
233	" " (center yellow)	10
233	" " (center mottled)	4
234	Light red violet	11
234	" " " (center light)	29
234	" " " (center mottled)	3
242	Dark red red violet	2
242	" " " " (center yellow)	3
243	Red red violet	39
243	" " " (center yellow)	30
243	" " " (center mottled)	29
333	Red gray or russet	1
333	" " " (center yellow)	20
333	" " " (center mottled)	2
334	" " " (center mottled)	3
355		1
	"Albino" plants, good size, but very pale throughout	2

Alternate rows of the two species of *Tragapogon* were sown the previous summer in Plot III., Series V.; the seed being from cross-pollenized flowers of the preceding season. Two hybrid plants appeared in 1902 in the *T. pratense* rows and six in those of *T. porrofolius*. The seed of these first-generation hybrids and selected seed of the second-generation plants in Series VI. have been sown in Plot IV., Series III.

The number of seeds produced by individual plants of the second generation has been much greater than that produced by those of the first, and plants of the third generation have been still more prolific.

EXPERIMENTS IN CROSSING LIMA BEANS.

In 1900 twenty plants were secured as probable crosses between the "Henderson" and "Burpee" dwarf lima beans. The results with the seeds from these plants are given in the report for 1901. A considerable portion of the Experiment Area has been occupied with the second generation of these crosses the present season, and the work of harvesting the crop is in progress as this report is closed. It can only be said now that there was considerable variation in the various lots, some being small-podded, prolific and early like the "Henderson" parent, while others were large-podded and comparatively late and small bearers.

Last year there were eight plants of the crosses that required poles. Seeds from these were planted separately, and, with but few exceptions, the plants have required poles. Many variations are to be met with among these, and there are indications that with careful selection a number of new pole sorts, as well as bush kinds, may be obtained in coming years. The yield upon some of the plants was quite remarkable.

CROSSED CUCUMBERS.

During last winter crosses were secured in the greenhouse of the "Telegraph" cucumber upon the "Znaim," the seeds of which were planted in Belts 1, 2 and 3 of Plot III., Series III., with good results.

The "Znaim" cucumber takes its name from a thriving Austrian town, a short distance north of Vienna, and known far and wide for the enormous quantities of superior cucumbers grown in its vicinity. Seed of this variety was kindly sent me by Mr. D. G. Fairchild, Agricultural Explorer for the U. S. Department of Agriculture. In Circular No. 2* he states that "The Znaim cucumber is a variety of *Cucumis sativus* and belongs to the field cucumber class. The seeds of this variety were brought to Znaim by a certain Andreas Lutz, servant of one of the Moravian princes. They are reported to have been introduced over one hundred years ago and to have come from the south (or Orient). The seeds were distributed throughout the county of Znaim, and from that early date the culture of this cucumber has been a lucrative one.

* "The Cultivation of Znaim Cucumbers" Section of Seed and Plant Introduction, U. S. Department of Agriculture, January 10th, 1901.

"The statistics show that, while in 1885 only 910 acres were devoted to cucumbers in the neighborhood of Znaim, in 1895 there were fully 2,000 acres of the vegetable. The yield in 1885 was more than 150,000,000 cucumbers, while in 1895 it reached the maximum production of over 336,000,000. In the last ten years the acreage has more than doubled. The average annual yield per acre has been about 165,000 cucumbers."

The "Znaim" cucumbers were grown upon the Experiment Area in 1901, and from seed thus secured plants were obtained for the crossing in the greenhouse. The field-grown "Znaim" cucumbers were short and broad when ripe, perhaps half the length of a "White Spine," with a rough skin that was a dull yellow in color.

The "Telegraph" is perhaps the most popular indoor cucumber, and is remarkable for its length, seedlessness and firmness of tissue. Sometimes they are two or more feet in length; two inches in diameter.

One of the points in mind was to obtain a field cucumber of good size, with a superior flesh and a tendency to produce few seeds. Plate V. shows two average fruits much reduced in size. The texture of this crossed fruit is good, the shape is desirable and there are but few seeds. As in the "Telegraph," there are sometimes constrictions in the fruit where there are no seeds. It, of course, remains to determine whether the form will hold and the seediness prove acceptable.

Plot IV., Series II., was devoted to "White Spine"—"White Pearl" cucumbers, descending from the crosses of 1899. Seeds from several of the most striking variations of the previous season were sown, and, in the resulting crop, there seemed to be much less variation as to size and shape of fruits than in 1901. A majority of this year's fruits were smaller than the "White Spine" and larger than the "White Pearl." The plants from one of the selections of 1901 yielded fruits rather larger than the "White Spine."

In color, the crop, on the whole, seemed to show the influence of both parents, and in all the fruits examined there was the usual number of sound seeds. None of the fruits were spineless.

Cucumber Blight.—This season's plants became seriously infested with the cucumber mildew, but not until the fruits had begun to ripen.

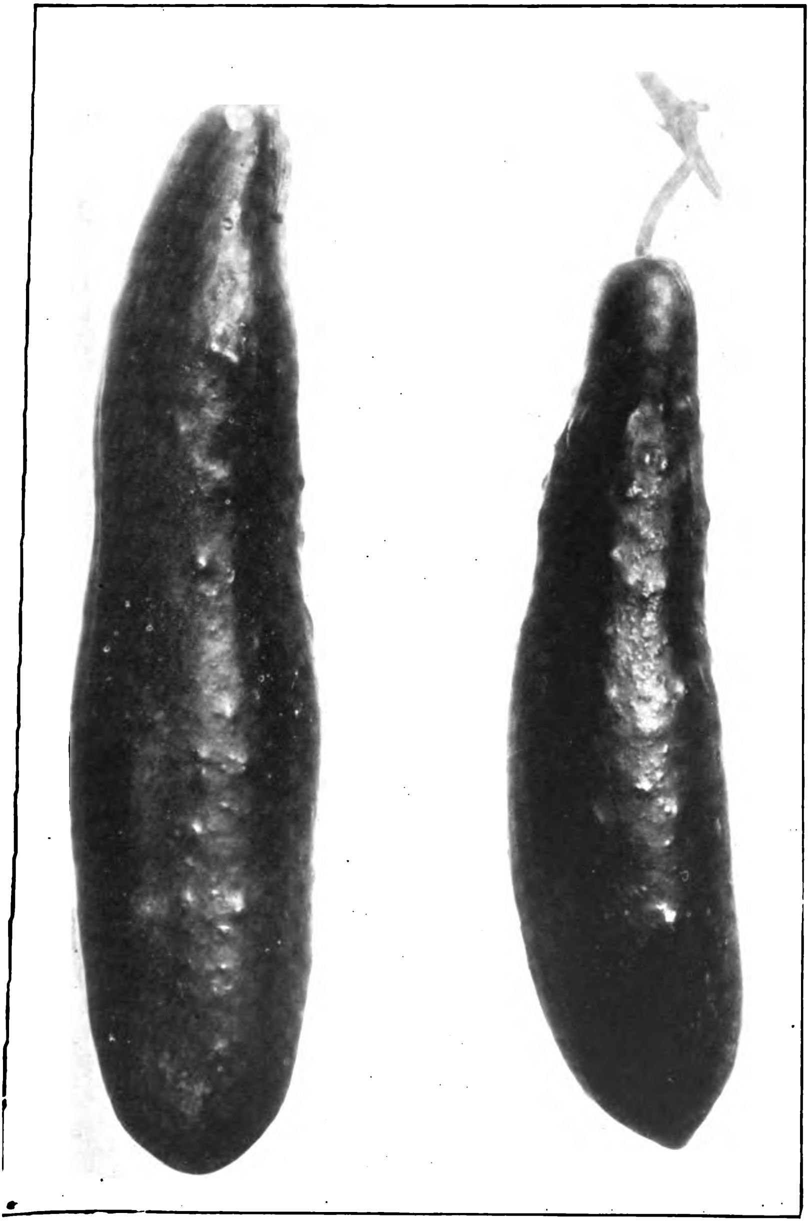

PLATE V.
Cross of "Telegraph" Cucumbers upon the "Znaim."

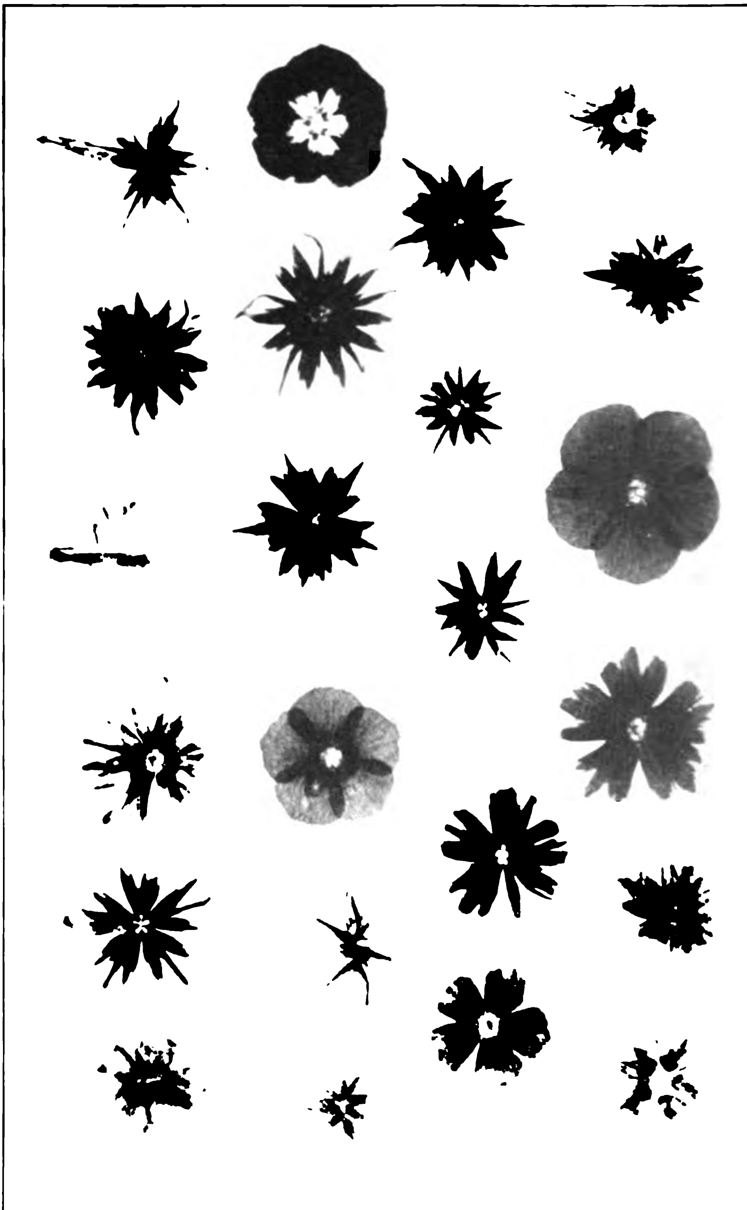

PLATE VI.

EXPERIMENTS WITH PHLOXES.

The *Phlox Drummondii* is a native annual of great merit as an ornamental plant, and for the last two years has received attention in the Experiment Area. Twenty-four commercial varieties were grown in 1901, as listed in the report for last year. Several crosses were made in the field, and the offspring were grown to some extent in the greenhouse the following winter.

During the present season the work has been continued in the field, and a number of crosses have developed of considerable interest. The *Cuspidata* (No. 12, of 1901) variety is peculiar in having the petals extended into long teeth and giving a star-like form to the whole bloom. A number of crosses were made upon this, showing many variations of interest from the parent type. Some of these are shown in Plate VI., where the forms are easily seen, but the interesting variegation is largely lost in the photograph and engraving.

It still remains to fix some of the most attractive forms so that they will come true from seed and become satisfactory varieties for the general grower. The experience of 1901 has been repeated, namely, that the phlox is a very satisfactory ornamental plant, giving a bed of much beauty and a constant supply of handsome blooms. One can have a single solid color or ribbons of mixed shades, as the fancy suggests.

CROSSED PLANTS IN THEIR SECOND GENERATION.*

In the following statements the facts are derived entirely from observation and study of some truck crops with which breeding has been attempted during the past few years at the Experiment Grounds of the Botanical Department of the New Jersey College Experiment Station.

CORN.—In the hope of making a new variety of corn and at the same time study some of the problems in connection with plant breeding, two standard sorts were selected, one a white kind, the "Egyptian" and the "Black Mexican." It scarcely need be said that these two varieties, while both of first quality, are quite unlike in other respects than color. The "Egyptian" produces a large, white ear, with the rows of grains ten or more, while the "Mexican" has a com-

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***Outline of paper prepared for meeting of the Association of American Agricultural Colleges and Experiment Stations in Washington, November 19th, 1901.**

paratively small, black, eight-rowed ear, with the plant smaller and earlier maturing than the "Egyptian."

By alternating the rows of hills in the plot the first year—1899—a thorough mixture of the two was secured. As the "Egyptian" had the better style of ear for the present market, the crosses upon the "Mexican" was discarded and only the pinkish grains of the "Egyptian" were selected for planting of 1901. One plot of one-twentieth of an acre was planted entirely with the pink grains from a single ear of the "Egyptian." This proved to give a very even set of plants of universal vigor, from which fully two bushels of ears were harvested. The only thing that needs further to be said concerning this result was the exceedingly uniform nature of the ears. There were none that were with all black or all white grains, but with the white and the pink so mixed that no row of grains was far from the average of all others upon the same ear or any other ear. As the pile lay before me it was easy to think that a variety of corn had been established that was an unvarying mixture of white and pink grains.

From selected ears, chosen for size and shape and number of rows upon the cob, the pink grains were used for the second planting (1901) since the mingling of the two parental varieties. The same plot of ground that was in corn in 1900 was again planted, so that any variations due to surroundings might be as far as possible removed. From the first the corn was uneven, some plants growing faster than others, while 10 per cent. were albinos and did not survive beyond four weeks or so. It was observed that many of the stalks, while quite small, matured their ears and browned before others were in the silk, while at the time of harvest in September there were certain plants still green and the grain still in the "milk."

Coming now to the ears, it was evident that the pink grains were in far larger number than the previous season. There were no ears entirely white, but some of them approached in this respect the "Egyptian" type, and in shape and number of rows this parent was decidedly in evidence. On the other hand, there were some eight-rowed ears that had all the grains of the same color and that of a dark-lead shade, approaching the "Black Mexican" type. There were other stalks that bore ears with an intermixture of white and nearly black grains, there being no suggestion of pink anywhere. Still other ears were entirely pink, no white or black showing in any of the grains. As a rose-colored sweet corn was one thing in mind at the

outset, these solid-pink or pale-red ears became a hopeful indication that the end was possibly in sight.

The point that concerns us in this paper is that, while in the first year from the crossed seed the variations among the progeny was very slight and all ears showed unmistakable evidences of the cross, the same was not true to the same extent the second season. Then there was a decided tendency to depart from the form produced the year before and some plants to be small and to mature early, like the "Mexican," having the dark, solid, eight-rowed ears of that variety, while others grew large and late, with the characteristics of the "Egyptian." While no ears were solid white, there was a tendency to unequal distribution of the color; a production of an increased percentage of the pink, and, finally, some ears were entirely of the reddish grains.

Cucumbers.—This is the second season with some crossing experiments with cucumbers. In 1899 the "White Spine" and "White Pearl" were crossed. The seedlings the succeeding year were comparatively uniform in plant, flower and fruit, the latter being of good size and combining the characteristics of both the parents. There was a blending of the green of the "White Spine" with the pale color of the "White Pearl," etc. The present season forty-eight hills were planted with the seeds from the crossed fruits. It made an unusually strong lot of plants, that covered the ground with a foliage that varied among the different plants, but the range of peculiarities shown by the fruits was remarkable. They were of all colors, from the deepest green to those as white as wheat flour. Some of them were long and slender and others as round as apples. Among those with smooth skin were lying others with numerous spines, some small, other large, while not a few were striped or mottled. As the hope from the beginning was to get a smooth fruit, it looks as if the desire may be met by proper selection.

Beans.—In 1900 a cross was obtained between the dwarf Henderson and Burpee lima beans. There were twenty of the crossed plants that in themselves differed quite widely, some adhering to the Henderson and others to the Burpee type, while many were intermediate.

During the present season seedlings of these crosses have been grown, and from the time the cotyledons appeared until the harvest the plot has shown that it was a crossed lot of plants. Among other things, seven of the plants early manifested a tendency which was gratified, and they have turned out to be pole beans differing in quality of pod,

seed, etc., from other pole limas—that is, while there was a reversion, it may be said, in the tendency to twine, the variety is not of either sort of ancestral type; in fact, no two of the pole plants are alike. One wonders what may come from the seed in coming years.

TOMATOES.—Crosses have been made between the small, upright, red-fruited "Dwarf Champion" and the large, spreading, yellow-fruited "Golden Sunrise" tomato. During the first season, out of 183 seedlings, all except 10 came true to the mother parent, and while it was evident that the plants were crosses, there were but few which showed remarkable peculiarities. Two were very large and produced a limited number of fruits, with comparatively few seeds. These seeds, when germinated, showed from the first a strange lot of seedlings, no two of them being alike; and most peculiar of all was the fact that many were monstrous in form, being without one cotyledon or the pumule; and such failed to live. With 40 seedlings from one of the original "Giants," a plot of ground was set, and the season's record of these plants shows a wide variation. Some were "potato-leaved," while others had foliage of a slender type; some of the plants grew entirely upright, with a very stiff stem, while others sprawled at length upon the ground; some produced red fruits of large size and others with the size of cherries, while one was plum-shape. The yellow-fruited plants were nearly as numerous and variable.

EGGPLANTS.—Last year a cross was effected between two varieties of eggplant, namely, the "Long Purple" and the "New York Improved Spineless." These were reciprocal, the combination being to improve the quality of the "N. Y. Improved" by a union with one of small size and high quality. During this season a large number of the crosses have been raised, and the most noticeable feature of them is their nearly uniform character, whether the cross was made in one direction or its opposite. In passing, it may be also stated that the vigor of the plants was remarkable, the yield large, of fruit of high quality, and a handsome, long, pear shape, with the seeds all well down toward the blossom end. So satisfactory has this cross been the first season that all growers who have seen the plants desire some of the seed. It has been withheld upon the ground of a doubt as to its fixedness. It is not unlikely that another year will show many deviations, so that selecting will be required to establish the cross even more than one variety should they be desired.

SALISFY.—All of the above instances of plant breeding have been

ions between varieties of the same species—that is, crosses. With salsify the combination has been between two species, and the re- t is a genuine hybrid. The two parents in this instance were the 'den salsify and the wild species. The two agree in many char- eristics, but are widely different in the flower, particularly the color, ich is a shade of violet in the garden sort and unmixed yellow in other. Last year, in their first season, the hybrid plants were ily recognized by a combination of the qualities of the two species, : most readily of all by the color of the flowers, which was dark red let. There were two types of these direct hybrids, differing only the amount of yellow in the center of the head—that is, there were purple red clusters and those that in distinction may be termed low-eyed. The type was constant upon any one plant, and number each type was about equal. Coming to the seedlings from these nts that were grown by the hundred this past season, the case is te different, and no less than thirty-six colors or hues found, as ermined by Prang's color chart. Of these the thirteen with larger mbers out of 200 plants examined are as follows: Yellow, 10; ht yellow, 12; lighter yellow, 6; darker orange red orange, 9; darker orange, 6; darker red, 23; dark red, 13; light red violet, 9; lighter violet, 7; violet red violet, 23; light violet red violet, 35; lighter let red violet, 29; dark violet gray, 6. Both parents are repre- ted and many intergrades, but the garden salsify has 103 violet ls to 28 plants that represent the yellows of the wild species. It seen that while the first year there were two uniform types as to ors, in the second season it is far otherwise. In short, there was ride diversity, with a strong tendency to return to the parent forms, t at the same time many intermediates.

All of the cases cited show that the second generation is the earliest ment when the real results of the cross show themselves, after which fixing of the desired new forms must begin by selecting further eding with one or other parent form by inbreeding or a combina- n of all these means.

EXPERIMENTS WITH LAWN GRASSES.

The nine plots of grass selected in the spring of 1896 have been ot closely cut with the lawn-mower during each season, and notes de from time to time upon the condition of each plot. The follow- table shows the species of seed sown in each plot, and the condition the stand of grass, in percentage, for the past seven years:

Plot.		1896.	1897.	1898.	1899.	1900.	1901.	1902.
1.	Meadow Fescue (*Festuca pratensis* Huds.)......	90	50	40	45	55	60	60
2.	Fine-leaved Fescue (*Festuca tenuifolia* Sib.)...	5	50	40	40	40	45	45
3.	Sheep's Fescue (*Festuca ovina* L.)..	10	50	40	40	30	25	40
4.	Rhode Island Bent (*Agrostis canina* L.).........	80	80	90	90	90	95	95
5.	Wood Meadow (*Poa nemoralis* L.)...............	60	65	70	85	80	85	90
6.	Kentucky Blue (*Poa pratensis* L.)................	50	65	90	90	85	85	90
7.	Rough Meadow (*Poa trivalis* L.)...................	90	65	70	70	45	70	60
8.	Redtop (*Agrostis alba vulgaris* With.)............	100	90	70	60	25	25	20
9.	Perennial Rye (*Lolium perenne* L.)................	100	85	70	40	20	15	15

It is seen that the "Rhode Island Bent" holds up well, and the stand this autumn, at time of last inspection, was near perfection. In the dry weeks of summer it becomes brown, and for this reason the present rating may be high. It is exceptionally fine in texture. The "Kentucky Blue Grass" has proved very satisfactory for the last three years, but some weeds have crept in the present season and lowered the percentage somewhat. In the "Wood Meadow" plot the grass has held its place for three seasons. The "Meadow Fescue" has made a gain this season over the previous year. Being at one end of the rows of plots, it is favored by a border gutter along the side of the plot. The "Redtop" shows a poor stand and the "Perennial Rye Grass" is nearly gone out. The leading weed in autumn is the crab grass, that fills in all vacancies. There are some dandelions that have not been removed from these test grounds.

EXPERIMENTS WITH WEEDS.

A piece of ground 11 by 33 feet, called "the weed belt," has been continued for the sixth season.

The fourteen most prominent weeds in this neglected area in 1902 were the following:

1. *Rumex acetosella* L. (0), (7), (4), (3), (1), (1).
2. *Daucus Carota* L. (12), (0), (0), (4), (5).
3. *Bromus racemosus* L. (0), (0), (0), (0), (2).
4. *Polygonum Pennsylvanicum* L. (0), (6), (3), (2), (2), (4).
5. *Abutilon Abutilon* L. (7), (2), (6), (6), (3).
6. *Chrysanthemum Leucanthemum* L. (0), (0), (0), (9), (6).
7. *Silene noctiflora* L. (9), (13), (14), (7), (7).
8. *Taraxacum Taraxacum* L. (0), (0), (9), (5), (8).
9. *Convolvulus arvensis* L. (0), (0), (0), (0), (9).
10. *Melilotus alba* Lam. (0), (0), (0), (12), (10).
11. *Oxalis stricta* L. (0), (0), (0), (8), (11).
12. *Ambrosia artemisiaefolia* L. (3), (5), (1), (1), (14).
13. *Aster* Sp.
14. *Rudbeckia hirta* L. (0), (0), (0), (0), (13).

The number in parentheses indicates the rank that each kind of reed held in previous years, beginning in 1897.

Other weeds, arranged in the order of their importance, were—

1. *Chenopodium album* L.
2. *Plantago Rugelii* L.
3. *Rumex crispus* L.
4. *Arctium Lappa* L.
5. *Panicum sanguinale* L.
6. *Barbarea Barbarea* (L.)
7. *Hibiscus Trionum* L.
8. *Polygonum Convolvulus* L.
9. *Acalypha Virginica* L.
10. *Amarantus retroflexus* L.
11. *Plantago lanceolata* L.
12. *Ixophorus glaucus* (L.)
13. *Aster*, 2 species.
14. *Tragapogon pratensis* L.
15. *Tragapogon porrofolius* L.

Trifolium repens and *T. hybridum* were prominent in 1901 and rere equally conspicuous the present season. Occasional plants of '. *pratense* were observed; one tomato plant, a three-year old grape ine and a young cherry tree.

Weed Notes.

HORSE-NETTLE (*S. Carolinense* L.).—Mr. Polhemus, of Rocky Hill, anded the Director a specimen of this weed for identification, statng that it was becoming troublesome in the meadows in his neighborood.

CORN CHAMOMILE (*A. arvensis* L.).—The manner in which this lant can adapt itself to conditions may be seen in one portion of the 'ollege campus. Instead of being destroyed by frequent clippings of he lawn-mower, its usually erect or nearly erect stems have become rostrate. Roots are put forth from their joints, binding them closely ɔ the ground, and one plant will spread over a considerable area in a ingle season.

GROUND IVY (*N. Glechoma* Benth.).—In some of the lawns about Iew Brunswick this weed is becoming quite conspicuous.

AILANTHUS (*A. glandulosus* Desf.).—The owner of a lawn containıg a few ailanthus trees is annoyed during late summer and fall by he great number of ailanthus seedlings. One of the trees was cut own in the spring, and from its large "surface" roots many sprouts rere sent up throughout the season.

NOTES UPON CLUB-ROOT.

Since the announcement of the proposition that the cancer in the human subject, particularly of the stomach, is due to an organism closely related to and perhaps indentical with the *Plasmodiophora Brassicæ* Wor., there has been a new importance placed upon the club-root fungus.

Fig. 2.
Club-root of Radish.

In case of the cabbage, the root is not eaten, and the edible portion of the "head" is rarely if ever infested by the organism causing the offensive cancerous growths in the root systems. With turnips, which are equally infested with the disease, the germs might find ready access to the alimentary canal. In the process of cooking it is probable that the fungus would be killed, but children are fond of raw roots, and, thus eaten, they might cause the lodgment of the live germs, where they, perhaps, would prove mischievous. Any badly-diseased turnip would naturally be rejected by all, but it is in those very slightly diseased that resides the most danger. In cutting away of an excrescence from an otherwise normal turnip there might be quite a portion of the infested tissue left behind, which, when eaten raw or after partial cooking, might prove injurious.

Radishes are usually eaten raw, and thus the germs might be introduced, especially when the fungus does not produce any striking distortion and the root seems unaffected. This latter is usually the

case with radishes, but that they are subject to the club-root disease is shown by the accompanying engraving (Fig. 2) of a specimen grown upon the trial grounds the present season. In this instance only the slender, lower portion of the root shows the galls, but not unlikely the edible part is also infested.

So long as there is strong suspicions that cancer is induced by the club-root germs in the roots of turnips, radishes and other cruciferous plants, it is well for people to be upon their guard and eat only healthy roots.

THE MILDEW OF LIMA BEANS.

Late in September numerous complaints of trouble with lima beans, with specimens, were sent in to the Station. The disease proved to be the mildew (*Phytophthora Phaseoli* Thax.) and merits a consideration here as being among the most destructive of the fungus troubles of the year.

The following is from Bulletin No. 151:* "This fungus was first described by Dr. Thaxter† and later more fully‡ considered by him, with engravings, some of which are herewith reproduced through the courtesy of the Connecticut Experiment Station. While the fungus is very easily seen in itself and also indirectly prominent from the destruction it produces upon the affected lima bean plants, its native home is somewhat of a puzzle, as evidenced by the following lines, written by its discoverer: 'Its origin * * * is purely a matter of conjecture, since, although it seems scarcely probable that so conspicuous a form should have been overlooked in so thoroughly explored a region as the New England and adjacent States, it has been equally overlooked in other parts of the world, if indeed it is a foreign importation.'"

It was not long before the mildew was met with in other States, and at the present time it is a serious menace to the growers of lima beans in New Jersey. The records show, for example, that the disease has been abundant in Bergen county. "Here the pole limas were so badly attacked that few or no pods were picked from some of the

* "Bean Diseases and Their Remedies."

† Botanical Gazette, vol. 14, p. 273, November, 1889.

‡ Conn. Agr. Exper. Rept., 13, 1889, pp 167–170.

fields. The mildew was worse with plants growing upon rich low-lands and where the same crop had been upon the ground the previous year."* Not only the young pods, but the whole flower clusters were

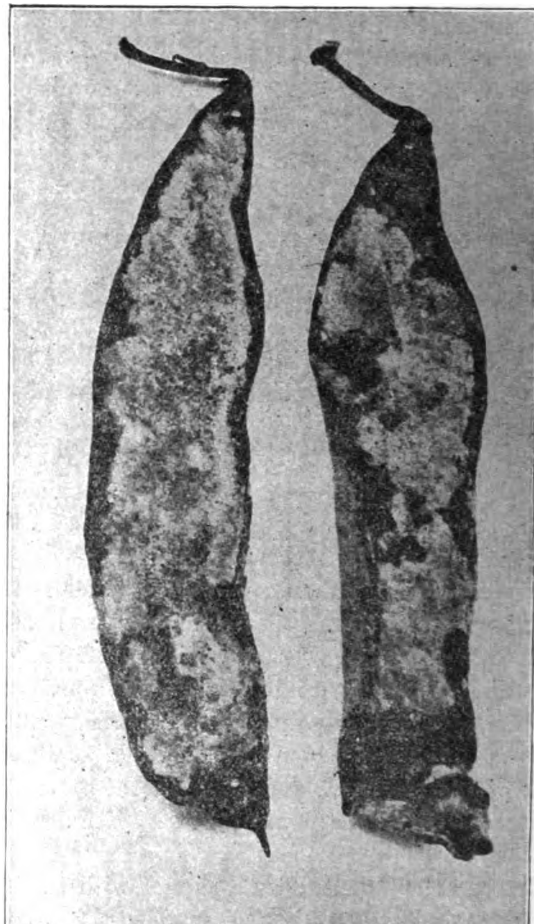


Fig. 3.
Lima Beans Affected with Mildew.

destroyed, and the dead tips of these stood up above the surrounding leaves of the affected plants. The general appearance of the mildewed pods is shown in Figure 3, the engraving having been made

* Rept. N. J. Exper. Sta., 1897, p. 297.

rom a photograph of two diseased pods, while the ruined flower clusters are similarly shown in Figure 4.

A microscopic examination of the affected part of the plant shows that it is penetrated by the slender threads of the fungus, which come

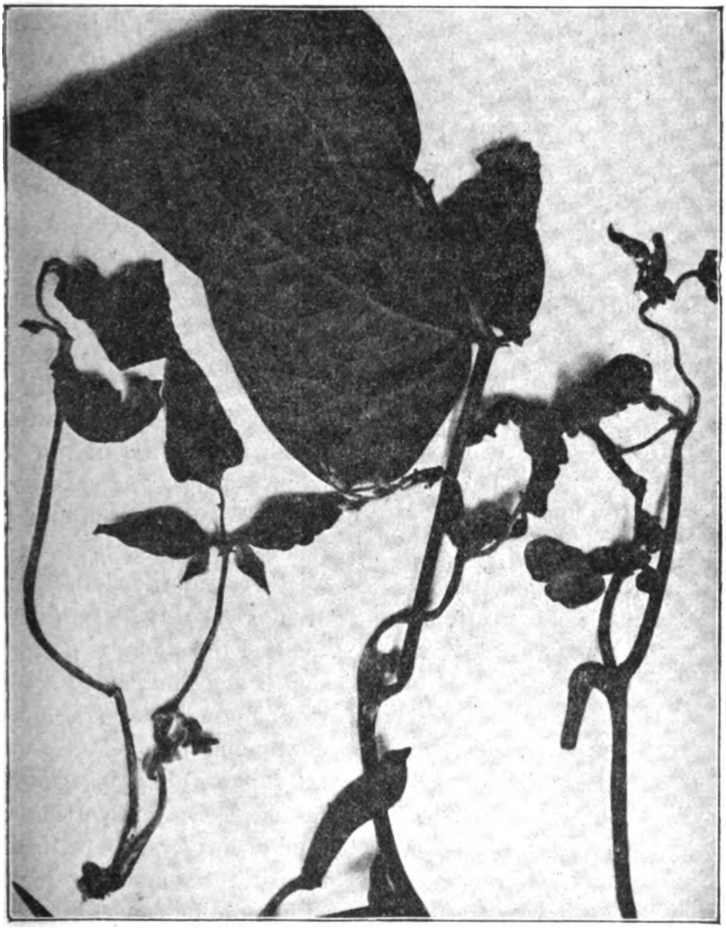


Fig. 4.
Lima Bean Flowers Ruined by Mildew.

o the surface and there produce tufts of branching filaments and bear multitudes of spores, all of which constitute the light mouldy covering and suggests the common name of downy mildew that is given to many members of this family. For example, there is a closely-related

mildew of the grape, another of indoor lettuce, another of onions, while the potato-rot fungus, often extremely destructive, is very near of kin to the bean *Phytophthora.* Figure 5 gives some of the microscopic details of the mildew. At *a* is shown a portion of the diseased bean pod with the threads passing through the stoma and bearing the spores upon their tips. A more enlarged view of the mildew is shown at *b*. The enemy in question belongs to a group of fungi the members of which are among the most fatal of all that afflict crop plants, and therefore demand prompt attention upon the part of the grower when met with.

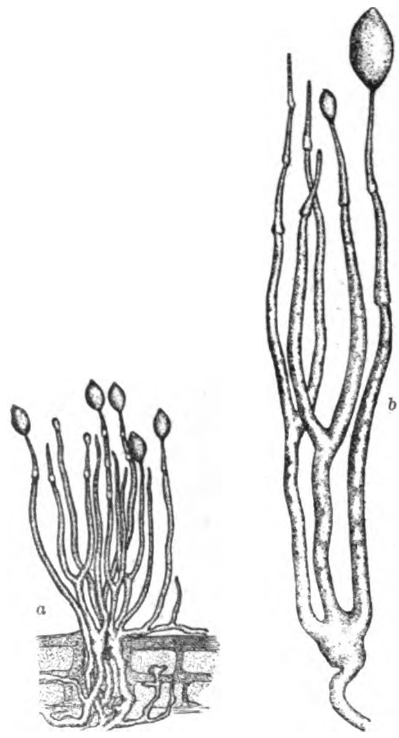


Fig. 5.
Microscopic Details of the Mildew.

Precautions.—Some hints as to precautionary measures may be gained by a knowledge of the habits of the group to which the mildew of the lima beans belongs. After a somewhat prolonged study of the relation obtaining between the weather and the development of fungi, it may be confidently asserted that there is no group that is more influenced by prevailing moisture than the downy mildews. The potato-rot fungus (*Phytophthora infestans* DeBy.) is particularly fond of wet weather, with high temperature, and the records show that 1899, the year when the bean Phytophthora was discovered, was remarkable for its excessive summer and autumn rains. In the case of greenhouse lettuce it is found that sub-irrigation is almost a complete preventive of the mildew, otherwise often quite destructive. It is safe to assume, therefore, that the amount of the bean mildew will depend quite largely upon the amount of moisture, and, in a dry season, but little damage may be expected from it. But the rains cannot

be controlled, and therefore the factor of precipitation remains an uncertainty. This much can become a practical matter, namely, the shunning of all lowlands that are apt to be wet. In other words, favor the higher and drier land for lima beans, because in such situations the mildew will be less certain to gain a foothold.

Dr. Sturgis* concludes his report of the remedies for the mildew as follows: "While from the nature of the disease it would seem probable that the use of fungicides would present many difficulties, yet, from experiments in which Bordeaux mixture, ammoniacal copper carbonate solution, sulphur and potassium sulphide were used, it appeared that when three applications of Bordeaux mixture was followed by two applications of ammoniacal copper carbonate solution the amount of the disease was greatly reduced.

"The conclusions drawn from the experiments with fungicides show that even in a season most favorable for the lima bean mildew, a thorough treatment of the vines with Bordeaux mixture will insure a crop. The selection of well-drained land and a light soil, reducing the number of vines in the hill and planting the poles erect, will insure conditions as little favorable to the development of the fungus as possible."

THE ASPARAGUS RUST.

In our own State, the following may stand as representative for the region centering in Middletown, Monmouth county, where large areas are devoted to asparagus for the New York market. Mr. James C. Hendrickson reports: "The asparagus fields look unusually well for this time of year. There has been very little rust this fall. Most of the 'Colossal' beds are gone. The 'French' and 'Palmetto' beds are now showing a little rust. I do not see much difference; if any, it is slightly in favor of the 'French' sort. The crop, I think, has been an average one considering the past six years." Mr. Charles Tindall, of New Monmouth, writes that "The crop was larger than the previous year, partly on account of warmer weather and sufficient moisture in May; also because of less rust in the fall before. The quality was also good. The growth of top is not as heavy as last year, caused by the dry weather at the time of plowing off the beds the last of June. The rust made its appearance about the first of September in a light form, but too late to materially affect the crop, excepting where it was

* Report Conn. Exper. Sta. 1897, pp. 159-160.

neglected in cultivation or badly infested with the beetle. To my knowledge there are only the two varieties in this section, 'Palmetto' and 'French Argenteuil,' and, so far as I have been able to ascertain, there is no material difference in regard to the rust, both being affected about the same. Seedlings that have been cared for well are practically free from rust and are looking very well."

For the southern section, providing asparagus for the Philadelphia market, Mr. John G. Whitall, of Woodbury, writes: "The crop the past season was a fair one, but the rust is now probably worse than ever before, many of the fields being entirely dead. The rust did not make its appearance as early in the season as usual, but since appearing has been very destructive. The 'Palmetto' does not show the effects of the rust nearly as badly as other varieties. In one or two cases, where beds of 'Palmetto' have been kept entirely free from grass and weeds, the rust does not seem as bad as where these have been allowed to grow."

For Vermont, Mr. W. J. Morse, Assistant Botanist of the Experiment Station, reports: "We have been on the lookout for it for several days and have found very little of it, where in years past it has been quite prevalent. Professor Jones is of the opinion, therefore, that it is not occurring as much in this locality this year as usual."

For Massachusetts, Professor Stone writes: "I think I can say, in general, that this year has been a very good one for asparagus. By that I mean there has been very little rust. We have had plenty of rain all through the season, and, according to my theory of rust infection, we should not expect much in such a season. I know that they have it on Cape Cod to some extent, but one large grower told me that it was far less than during other seasons. Our beds at the College at the present time do not show a particle of the fall stage. I saw a good illustration of spraying this summer with Bordeaux mixture alone. One small bed was divided into two sections, one-half of which was sprayed and the other half not. The gain on the sprayed portion was enormous compared with the unsprayed. This was done by a man who owns sixteen or seventeen acres of asparagus, and he certainly covered his plants thoroughly with Bordeaux. They were covered so thoroughly with Bordeaux, large and small branches, that they had the appearance of a blue spruce. This experiment convinces me that if plants are thoroughly covered, every portion of them, with the Bordeaux mixture, that good results can be obtained. The difficulty

has been, however, to thoroughly cover the plants with Bordeaux mixture."

Professor Stewart writes for New York: "I am sorry to say that I can give you little definite information except for eastern Long Island. I have just returned from a trip to that section, and I find that there the rust is somewhat more destructive than it was in 1901. Many of the young buds are considerably injured by the disease, the plants being already dead or brown, but the majority of the older beds are only moderately affected and are still very largely green. The few beds which I have observed in Central New York are very slightly affected, and my impression is that there is not much of the disease in this part of the State."

From Delaware, Professor Chester reports as follows: "I have found the rust generally prevalent throughout Delaware during the present season, but probably not more abundant than last year. I have, however, only general impressions to convey on the subject."

Professor Buckhout writes for Pennsylvania: "Up to the time of receiving your letter I had not noticed any asparagus rust on our bed, but on looking it over to-day I find there is quite a showing, though hardly so much as in previous years; certainly no more. I may say that we have done no spraying and that our bed is small, scarcely, if any, over one-fourth acre. The general course of the growing season has been as follows: A dryer than usual spring, culminating with unseasonably dry, dusty weather up to June 10th. Rain then began and was almost daily until about July 15th to 20th, when there was a gradual diminishing until August 1st. August was midsummer dryness, unbroken by rain until September 12th, but no rains of consequence until September 25th."

For Virginia, Professor Alwood sends the following: "This year the asparagus rust has appeared in our plantations here. As it appeared in some young plants set last spring, I have no hesitancy in saying that the fungus must have been brought from the nursery. These plants were purchased at a small nursery near Richmond, which would go to show that the territory is infested; and I doubt not that this disease is prevalent about Richmond, as it is at some points along the coast."

Professor Selby reports for Ohio: "I can give you but little new information concerning asparagus rust. Indeed, I have no definite notes save the general one that it has become spread over almost the entire State, locally."

Professor Arthur reports from Indiana: "The rust in Indiana did not appear very early this season, but it was general, probably few or no patches of plants escaping. While destructive, it does not seem to have been uncommonly so, as might have been supposed from the wet season. No æcida have yet been found within the State. Here at Spirit Lake (Iowa) I find the rust, but there is so little of it as to be economically unimportant. At Decorah, Iowa, as you may be aware, Mr. Holway found æcida on onion leaves, close to rusted asparagus plants (and nowhere else), which, in the light of Mr. Sheldon's studies (reported in *Science*), appears to indicate that asparagus rust is not confined to a single genus of host plants, at least in the æcidial stage. Whether *Puccinia Porri* is identical with *Puccinia Asparagi* or not it would be rash to say. It is safer at present to assume that they are distinct, but that the latter may occasionally produce æcidia on onion almost or quite like the æcidium of *P. Porri* in morphological characters."

Doctor Burrell reports for Illinois: "The asparagus rust has appeared in many new places in various parts of Illinois during the last year, and it has been found within that time in quite a number of places where it had been earlier introduced, but of which we had no previous knowledge. I think, all told, there must be at least one hundred separate locations of the disease now in our State. I have had no practical experience in combatting it and have no definite knowledge as to its extermination within our borders. It is true, however, that certain statements have been made by practical growers, going to show that they have kept it down by spraying with Bordeaux mixture. I have no definite evidence concerning anything about the disease now save this fact—that it is evidently increasing considerably with us, and I think it is doing a good deal of damage."

For Iowa, Professor Pammel writes: "The *Puccinia Asparagi* is on the increase, but I have no extensive reports from other sections of the State, and I notice that additional plots are affected in this vicinity."

Professor Bessey writes for Nebraska: "Mr. John L. Sheldon. Instructor in Botany in the School of Agriculture, who has made this rust a special study for a number of years, says that there is not as much this year as last. In regard to the possible connection between the abundance of rust this year and the peculiarities of the season, he says that of course this season has been wet and the rust less abundant. Whether there is any connection between these two points he is not

prepared to say. However, he says that there is less rust on low land than on high land, and you may put this fact with the other and make what you can out of it. Many people burn the brush at the end of the year, and where this is done there is now little or no rust. In some instances the owners, after burning the brush, run over the ground with a disc cultivator, and this seems to do some good also. In a particular case, near Lincoln, the asparagus is grown in an orchard where burning and other precautions cannot be resorted to, and it is a fact that there is more rust in this asparagus plot than elsewhere. Still the season is one which is characterized by a small amount of rust on the asparagus."

Professor W. R. Shaw reports for Oklahoma: "I have neither seen any of the rust nor received any report of its occurrence in Oklahoma and Indian Territories, and Mr. Morris, our Horticulturist, informs me that he has never met with this rust in this region."

Professor Saunders sends the following for South Dakota: "I have nothing in particular to report with reference to the asparagus rust. The only two patches of asparagus that I know of were so badly infested last year that they were plowed up and destroyed last fall. A few scattering volunteers in our timber claim were quite as badly infested this year as was the patch of asparagus last year."

For North Dakota, Professor Bolley sends the following: "This time I am able to report to you that the asparagus rust is here with a vengeance. I am unable to give you any information regarding the influence of weather upon the disease. Last year we had a very dry season. The plot at the College, which is a large one, rusted some time in August, so as to be thoroughly brown. This spring has been an extremely wet one, so there was an abundance of moisture in the ground at all periods of the growing season, and this College bed was struck by rust so as to be thoroughly killed by the 15th of August, so dead that we cut it all down and are making some experiments as to the further effect of the rust, how to control it, etc. This bed at the College is one of the oldest asparagus beds in the country and has become thoroughly infested. Last year, on my own lawn, my bed of asparagus was killed by rust. I pulled all of the old stalks out of the bed, burned them up and covered it with ashes. The bed this year has borne no rust, but I simply consider it an accident; do not know why the plants have staid green until frost. The rust is spreading through the State, I know, because I have found it upon volunteer asparagus on numerous tree claims."

Professor Nelson makes a favorable report for Wyoming: "I again have the pleasure of reporting that the asparagus rust has not made its appearance in this State so far as I have been informed."

Professor Balmer, of Washington, sends the following: "I have seen no asparagus rust in this State, nor have I heard of any."

For California, J. J. Keegan, Secretary of the State Board of Horticulture, writes: "I beg leave to acknowledge receipt of your reports for 1899, 1900 and 1901, for which please accept my thanks. The information they convey will be of the greatest value to this Board.

"We are trying by all means in our power to prevent the introduction of the asparagus rust into this State. This Board has passed a resolution prohibiting the introduction of all asparagus roots and seeds from any place outside of California into this State. By this means we hope to escape it.

"The asparagus industry is rapidly becoming of the greatest importance, fields of 1,000 acres and upwards having been planted on the islands in the delta of the Sacramento and San Joaquin rivers, and the coming season many more will be added. Should the rust be introduced it would all be ruined, as the islands are very low and moist, protected by levees from overflow and most favorable to the propagation of fungus growths."

Asparagus Rust on the College Farm.

On October 23d a final inspection was made of the several varieties in the four plots. The field generally showed much rust and the brush was not vigorous. The larger size and deeper green of the "Palmetto" variety was evident from all parts of the field. The "Argenteuil" was little infested. Upon a basis of percentages, as assigned to the amount of rust in former years, the "Palmetto" and "Argenteuil" show 25 per cent., while the "Mammoth," "Elmira," "Columbian," "Colossal," "Brunswick" and "Cross-bred" have 75 per cent. of rusting.

Last year the percentages were 20 and 50. It was noted that the least rust was upon the plot where barnyard manure had been applied.

BROOM-RAPE UPON COLEUS.

The greenhouse during last winter was employed in part in testing the habits of certain seed-bearing parasites, as the dodders and broom-rape. It is interesting to note that a coleus plant standing near these

PLATE VII.

Coleus Plant in pot showing Broom-rape Parasite in Bloom near the soil.

experiments became infested with the species of broom-rape (*Orobanche ramosa* L.) that is sometimes quite destructive to the tobacco and hemp, particularly in Kentucky.*

Last year specimens were met with upon tomato,† which is a host closely related to the tobacco. In this instance the host is a member of the mint family and shows that this root parasite has quite a wide range of plants upon which it may possibly flourish. Plate VII. shows the potted coleus plant and the broom-rape that is growing upon it below the surface of the earth.

EXPERIMENTS IN GERMINATION OF CORN.

Thirty-two lots of corn were germinated with as little moisture in the soil as possible. Only lots Nos. 9, 10, 25 and 31 gave albinos. A duplicate set was grown in very moist earth, with the result that Nos. 9, 10, 22, 25 and 31 gave albinos. There was one albino plant in No. 22; otherwise, the numbers giving albinos were the same in the two lots. This would indicate that the albinism is in the seed or at least not induced by the amount of moisture in germination.

A considerable lot of small ears ("nubbins"), mostly immature, were placed upon moist moss and the scattered grains germinated. An albino seedling was a rare exception. This indicates that immaturity of the grains is not a condition for albinism.

Ears yielding albinos were selected and twenty grains from each row planted.

No. 1.			No. 2.			No. 3.			No. 4.		
Row.	Albinos.	Green.	Row.	Albinos.	Green.	Row.	Albinos.	Green.	Row.	Albinos	Green.
1...	1	19	1...	3	17	1...	1	19	1...	3	19
2...	2	16	2...	2	18	2...	2	18	2...	2	16
3...	..	19	3...	4	14	3...	..	20	3...	4	16
4...	5	14	4...	1	18	4...	4	16	4...	1	18
5...	2	18	5...	3	16	5...	2	18	5...	3	16
6...	..	18	6...	5	14	6...	..	20	6...	4	15

This indicates that the albinos are not confined to certain pairs of rows on the ear.

* Bulletin 24, Kentucky Experiment Station, 1890.

† Report for 1901, p. 435.

Tests were made of grains from ears when there were three (triplets) upon the stalk:

			Albinos.	Green.
No.	1.	Oldest ear	..	20
"	2.	Middle "	..	20
"	3.	Youngest "	..	16
"	4.		1	14
"	5.		1	15
"	6.		..	1
"	7.		..	2
"	8.		..	18
"	9.		..	14
"	10.		..	20
"	11.		..	17
"	12.		..	17

Here there were only two albinos, and both from ears of the same plant. These were the oldest and the middle ear upon the stalk.

A larger test was made of grains from ears where there were two (twins) upon the stalk:

			Albinos.	Green.			Albinos.	Green.
No.	1.	Older	..	17	No.	1	3	9
"	2.	Younger	..	20	"	2	1	18
"	3.		7	12	"	3	..	13
"	4.		3	14	"	4	1	19
"	5.		..	20	"	5	1	18
"	6.		..	18	"	6	7	9
"	7.		..	17	"	7	2	18
"	8.		..	17	"	8	1	11
"	9.		2	16	"	9	..	20
"	10.		..	19	"	10	..	20
"	11.		..	14	"	11	..	18
"	12.		2	12	"	12	..	18
"	13.		..	7	"	13	4	14
"	14.		..	15	"	14	2	17
"	15.		..	16	"	15	..	20
"	16.		..	15	"	16	..	20
"	17.		..	19	"	17	..	19
"	18.		..	18	"	18	..	18
"	19.		..	18	"	19	..	20
"	20.		..	9	"	20	..	7

In the first set only four ears yield albinos, two of which are the older and two the younger ears upon the stalk. It is to be observed that the majority of all the white seedlings came from the second pair of twins (Nos. 3 and 4) where both ears gave albinos.

In the second set nine ears gave albinos, four being of the older and five of the younger ears. It is to be noted that in all instances but one where one ear of a pair showed albinism, the other also did the same. This indicates that the whole plant is affected.

Special test of prolific corn was made as follows, twenty grains in a planting from each year:

	Ear.	Albinos.	Green.
Plant 1.....	A	3	17
	B	2	16
	C	1	19
Plant 2.....	A	..	20
	B	..	18
	C	..	16
Plant 3.....	A	5	12
	B	2	16
	C	5	13
Plant 4.....	A	..	20
	B	..	19
	C	..	17
Plant 5.....	A	..	20
	B	..	20
	C	..	18
	D	..	17
Plant 6.....	A	..	20
	B	..	20
	C	..	20
Plant 7.....	A	3	16
	B	1	18
	C	..	19
Plant 8.....	A	1	19
	B	1	19
	C	1	19
Plant 9.....	A	1	19
	B	2	18
	C	7	13
	D	2	16
	E	3	17

In this test it is noted that when one ear of the set of three to five from a stalk showed albinism, the others did also, with but a single exception. Plants 2, 4, 5 and 6 gave no albinos. The oldest ears (A) gave 3, 5, 3, 1 and 1 white seedlings, respectively, or a total of 13. The next oldest gave 2, 2, 1, 1, 2, or a total of 8. The third ear gave 1, 5, 1 and 7, or 14. The single fourth ear gave 2 and the fifth ear 3 albinos.

The white seedlings do not seem to be attributed to over bearing of the stalk or to age of the ear when twins or triplets are produced.

Several tests were made of inbred corn in contract with wide-bred ears. The former received only the pollen of the same plant, while the latter has the tassels removed before the silks were receptive.

Inbred Corn.	Albinos.	Green.
No. 1	13	47
" 2	15	38
" 3	7	48

Wide-bred Corn.	Green.
No. 1	60
" 2	65
" 3	65

There were seventy grains planted at four different times from each of the six ears. Of the inbred corn over a quarter were albinos, while none appeared among the two hundred seedlings of the wide-bred grains.

Plate VIII. shows the plants in one of the tests when two weeks old. Rows 2 and 3 are particularly poor, as shown in contract with the plants in row 4. The albinos, although present, are not easily seen in the engraving.

The number of tests in all the above-mentioned germinations is too small to warrant any conclusion, but the results as a whole point towards close fertilization as the cause. It would be well for all growers of corn to detassel the plants from which the seed ears are afterwards selected.

ON THE BEHAVIOR OF MUTILATED SEEDLINGS.*

The particular form of mutilation of seedlings here considered is that of the removal of the plumule. Several kinds of plants have been tested during the last twelve months in the deplumuling of the young seedlings. The first of these was the garden radish, representing a small, large-rooted and short-lived plant. Soon after the seedling was above ground the pumule was removed upon alternate rows of plants, while the other rows were left to grow normally. The first thing to observe was the much deeper green of the cotyledons of the deplumuled plants. This was followed by a remarkable elongation of the petiole and the large size of the obcordate blade, the former attaining a length of three inches and the latter a breadth of an inch and a half. These cotyledons were raised at an angle of about 45°, and the very dark-green blade had a thickness nearly double that of the normal

*Abstract of a paper prepared for the fifth meeting of the Society for Plant Morphology and Physiology, at Columbia University, January 1st, 1902, and published without illustrations in Torrey's February, 1902.

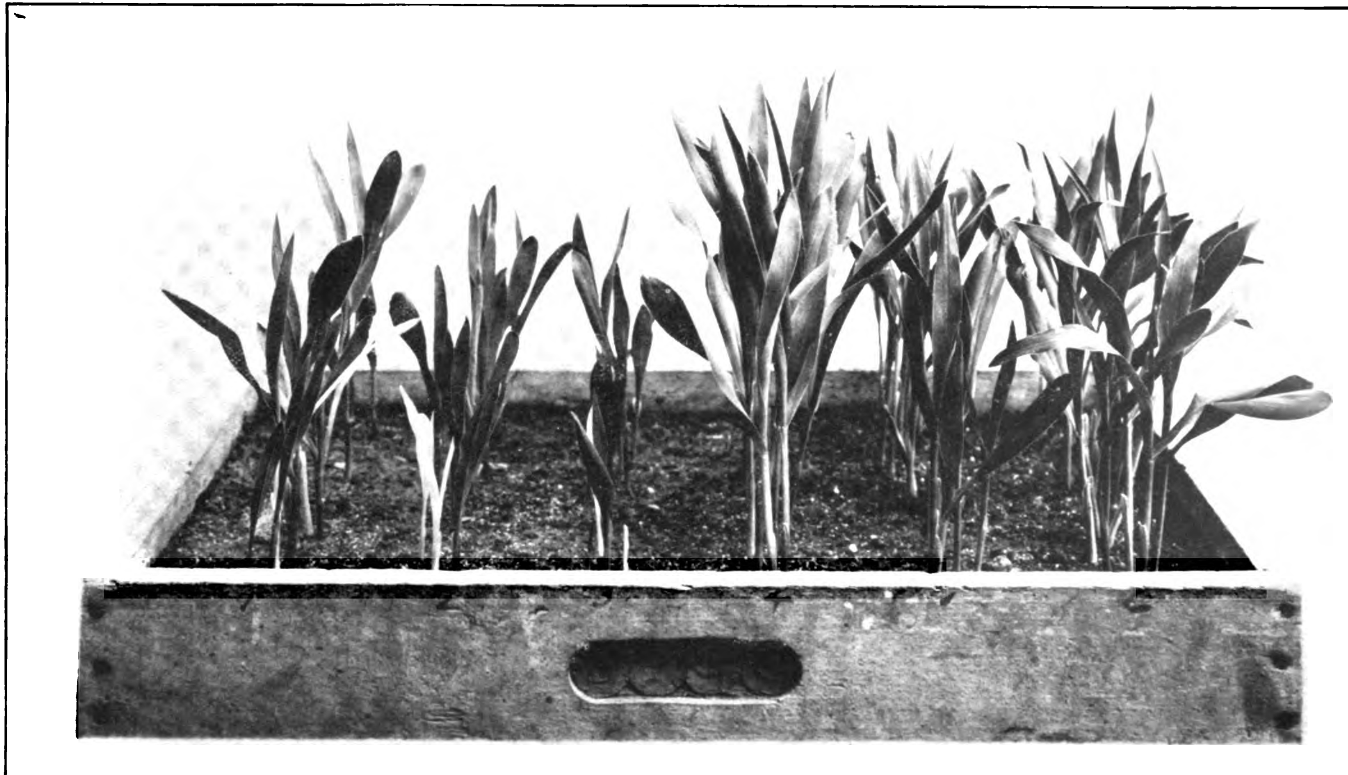


PLATE VIII.

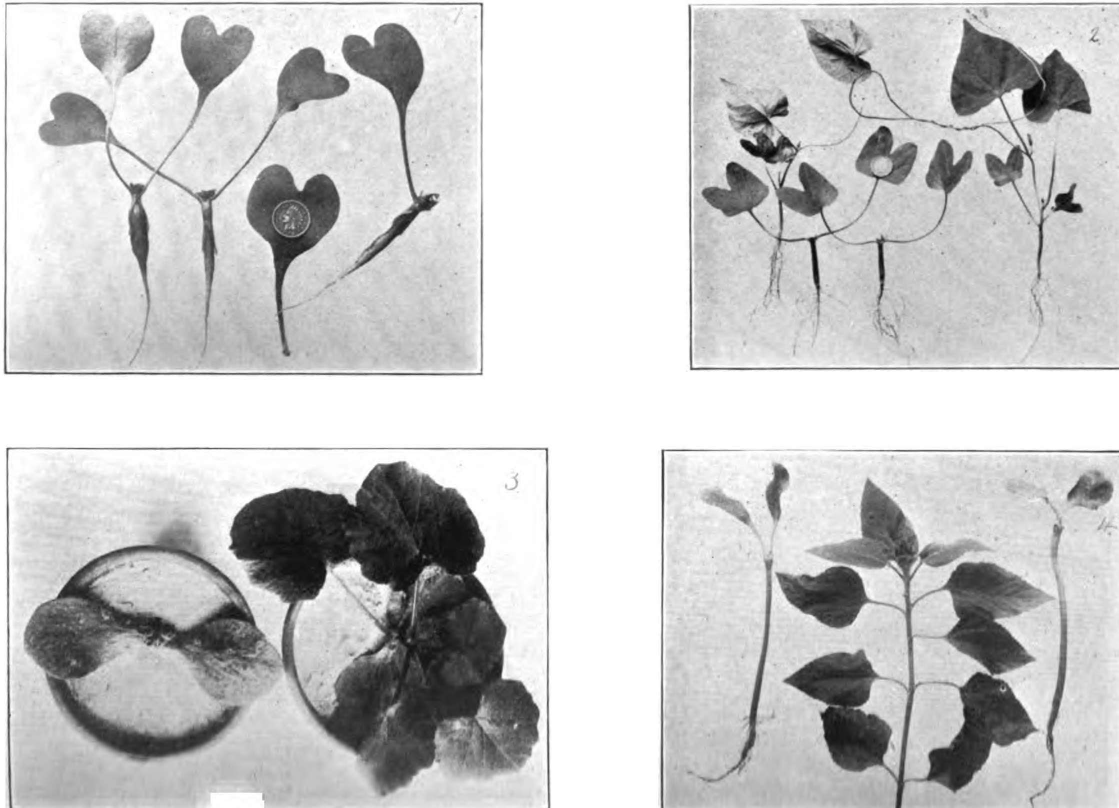


PLATE IX

Mutilated Seedlings. 1, Radish with Bud Removed. 2, Morning Glories with Bud Removed, one Normal. 3, Squash Deplumuled. 4, Sunflower Deplumuled, one Normal.

cotyledons. A microscopic examination showed that the greater thickness was due to increased size of the cells instead of to a multiplication of the layers. The chlorophyll was excessive and the amount of starch so great as to practically render them black when blanched with alcohol and iodized. The roots grew to nearly market size, and had the tests been made with a turnip-shaped sort instead of a long variety, it is very likely that the roots would have been fit for the table. See 1, Plate IX.

The second species was the common morning-glory (*Ipomœa purpurea*). Here the cotyledons are large in the seedling, but quickly are lost from sight by the development of the much larger alternate true leaves. After holding on for a few days, as a rule, the cotyledons lose their green color and drop from the stem. In the deplumuled seedlings petioles at once begin to elongate, as was shown to be true with the radish, while the remarkable green develops in the blades, that likewise become double or more the normal size and become the organs of photo-synthesis from the mutilated plant. Their dark green is shared by the long, arched petioles (quite different in this respect from those of the radish) and the hypocotyle. The latter becomes of twice the sectional area of the normal plants, that are now several feet high and bearing flowers and become a store-house for the starch, that is robbed of its proper use by the absence of any stem. The root system of the deplumuled plant is not different from that of the normal specimens. See 2, Plate IX.

A third type of plant put to the test is the Hubbard squash, the seedlings of which naturally have large cotyledons. In these the seed leaves remain near the soil, without any apparent elongation of the hypocotyle, but there is a remarkable increase in the size of the cotyledons, until they are sometimes four or more inches in length and very odd, to say the least. Normally, the true leaves come forth from the pumule rapidly, and, due to their large size, the cotyledons are soon out of sight and quickly wither away. Dwarfed squash plants, depending entirely upon the cotyledons, have been kept in apparently healthy condition for four months, the size remaining practically the same after the first four weeks. These plants, unlike those previously mentioned, need frequent attention, for buds will develop in the axils of the seed leaves, which, when removed, will be followed by others without any determined number. If left undisturbed a whole thick cluster of stems and small leaves will develop. See 3, Plate IX.

The eggplant, as representing a slow-growing type of bushy plant, was employed for the tests in question, and it was found that they behaved in a manner similar to the radish, in that the petioles became ridged and nearly upright, and bore the thick, almost fleshy, much-enlarged oblanceolate blades well up in the air and sunshine. In this form the deplumuled plants will stand still, in a very liberal sense of that term, for an indefinite time—not weeks, but long months.

The last type of plant to be considered is represented here by the common sunflower (*Helianthus annuus* L.). As with the other types, the plants in alternate rows were deplumuled. The first change was quickly observed, namely, in the enlargement of the cotyledons, but here the most noticeable thing observed was the elongation of the hypocotyle, which finally reached fully nine inches or double that of the normal plants. There is a greater tendency for pypocotyledonary growth in the sunflower than any other of the types named, and this was remarkably accentuated in the mutilated plant. The structure of this stem, even at the end of three months, retained, generally, the primitive structure it possessed as a young seedling—that is, for example, the wood zone was made of a series of stout bundles, evenly disposed, without the filling in and completion of the thick ring of zylen, so well demonstrated in the normal plant at the same age. See 4, Plate IX.

The experiments illustrate how an organ normally designed to store food for the developing seedling may persist, in case of an emergency, and take on a greatly increased size for that purpose. The petiole may assume a direction in connection to its enlargement that will aid the blade in its work of photo-synthesis. Along with these changes in the seed leaves there may be others in surrounding parts, particularly the hypocotyle when it becomes thickened, remarkably, and green in the morning-glory and greatly elongated, but slender in the sunflower. In case of the radish, a place for any surplus growth is provided for in the root naturally destined to be fleshy, and the hypocotyle is not modified.

Perhaps the greatest surprise is the length of time a plant will hold out when it is deprived of the means for making a successful struggle for life and all possibility of reproduction.

FUNGICIDES AND SPRAYING.

The fungicides employed in the greenhouse during the past season were kerosene emulsion and soap, and, at the Experiment Area, soda-Bordeaux.

The constituents of the emulsion were in the following proportions:

Kerosene	**2 pints.**
Hard soap	**2 ounces.**
Water	**8 gallons.**

This formula is the same as that frequently recommended as a greenhouse insecticide, with the exception that it calls for twice the quantity of water. To prepare, the requisite amount of "Ivory" soap was dissolved in about one gallon of boiling water, and, after removing from the fire, the kerosene was added. Drawing the solutions through a knapsack pump is a very satisfactory method of combining them. Ten minutes "pumping into itself" should produce a creamy mass that will not separate. After adding the proper amount of water the emulsion is ready for use. A considerable quantity of the concentrated emulsion may be set away in closed vessels and drawn out as needed.

The soap solution employed consisted of "Ivory" soap and water in the proportions called for by the emulsion formula, namely, two ounces of soap to eight gallons of water.

How Applied.—For testing different strengths of kerosene emulsion and soap upon a few potted plants, an atomizer was used; but for treating the larger number of plants in the bench, a knapsack pump was employed after the first two weeks. The atomizer is very convenient where only a pint or two is to be applied, but for larger amounts the knapsack pump is much more satisfactory, it applying the solution more thoroughly and in a much shorter time.

A—*In the Greenhouse.*—For testing the fungicidal values of kerosene emulsion and soap in the Station greenhouse, mildewed plants of *Phlox Drummondii* and the common verbena were employed. On November 8th mildewed seedlings of these were selected and transferred from the Experiment Area to the coolest benches in the greenhouse. They were disposed in twenty-one cross-rows, five plants to a row.

The disease thrived under the new conditions, and by the end of two weeks its presence upon the plants was very apparent. Spraying

was begun November 27th, and between that date and April 1st twenty-six applications were made. During cloudy weather, when the conditions were most favorable to the mildew, the applications were made every two days.

For a time there was no striking contrast between the sprayed plants and the unsprayed; but after the third week the mildew was much more conspicuous upon the unsprayed. These made but feeble growth and developed almost no flowers. Before the end of the season two-thirds of the phlox plants were dead. The check verbenas survived but were practically worthless.

The plants treated with kerosene emulsion, although not wholly free from mildew, were not sufficiently affected to prevent their making a vigorous growth, and in due time blooming freely until the end of the season. Plate X. shows a portion of the spraying experiment with phlox. The untreated rows are upon the right and treated rows upon the left.

About midwinter a verbena plant seriously affected by mildew was transplanted to a box and its foliage divided as nearly as possible by a board partition. One of these halves was sprayed every six days with kerosene emulsion, while the other was untreated. The appearance of the plant at the end of the season is shown in Plate XI.

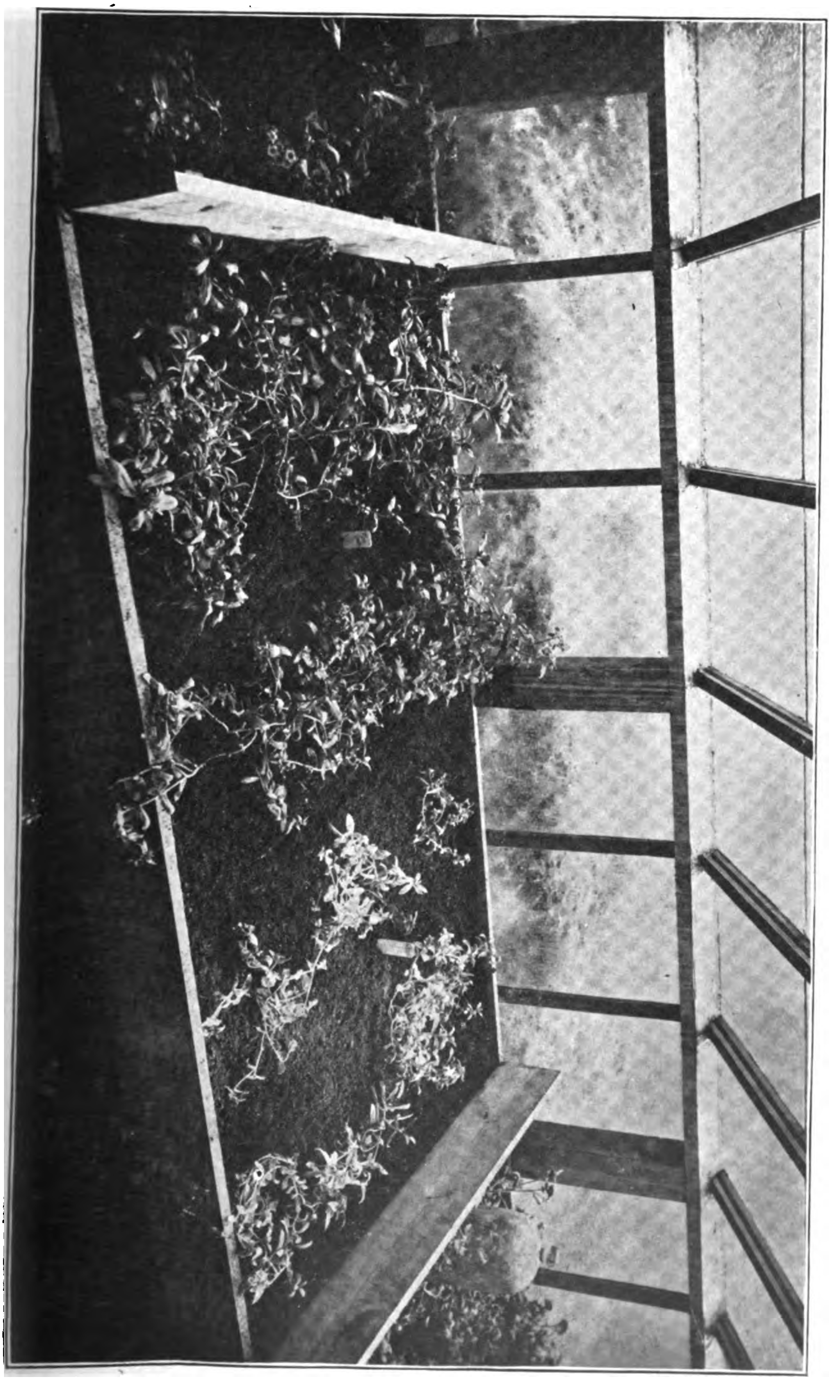
The soap solution was applied throughout the season at [illegible] intervals as the emulsion, and while its effect upon the mildew was apparent, the plants so treated were plainly inferior to those sprayed with emulsion.

A limited test was made of the fungicidal value of half and quarter-strength solutions of the greenhouse fungicides employed.

3	potted	plants	were	sprayed	with	half-strength	kerosene emulsion.
3	"	"	"	"	"	quarter "	" "
3	"	"	"	"	"	half "	" soap.
3	"	"	"	"	"	quarter "	" "

These plants were sprayed at the same intervals as those [illegible] bench. The half and quarter-strength emulsion seemed to [illegible] mildew about as well as the full-strength solution, but it is [illegible] to make a more extended trial of the weaker solutions before [illegible] their use.

Half and quarter-strength soaps checked the mildew but [illegible] plants so treated being severely infested.



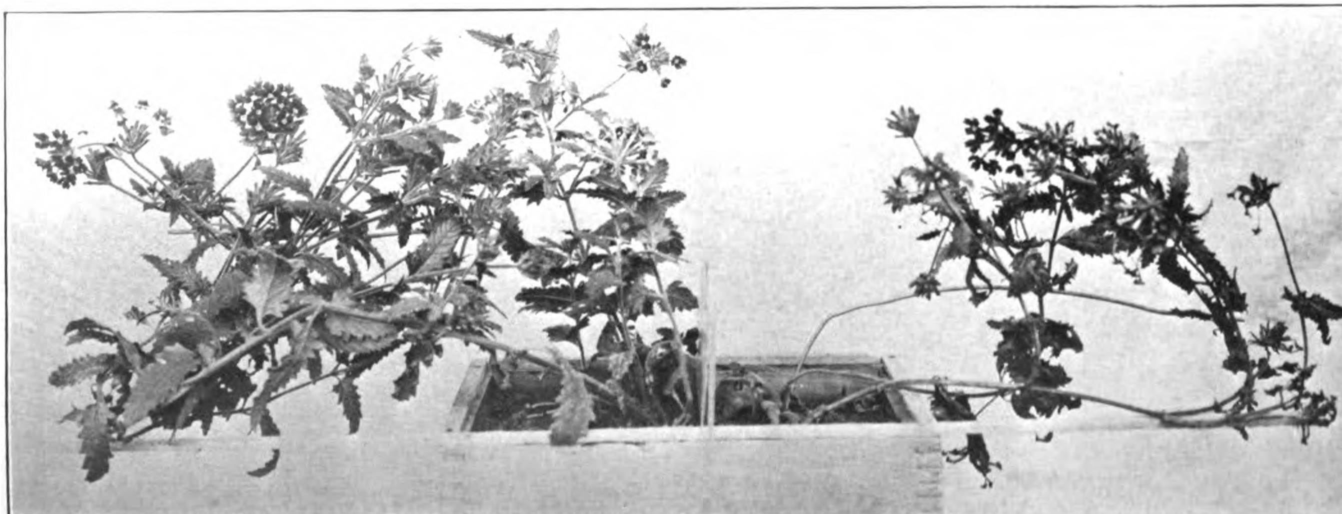


PLATE XI.

A Verbena Plant one half (right) of which was left Unsprayed, while the other was treated with Kerosene Emulsion.

B—*In the Field.*—There was practically no spraying during the past summer at the Experiment Area. It was intended to spray with soda-Bordeaux two belts of bush beans, one belt of stock tomatoes, one belt of watermelons and all the crossed cucumbers.

The first application was made July 12th, the second July 23d, after which it seemed almost impossible to repeat the applications as frequently as conditions demanded without neglecting other duties. Spraying was therefore discontinued. No appreciable results followed the two applications.

FUNGI AS RELATED TO WEATHER.

The following items are gathered from the "Weather and Crop Bulletins" issued weekly by the State Weather Service during the months of April to September:

July 8th—"Tomatoes backward and showing some blight;" "Plums rotting;" "Apples dropping."

July 15th—"Blight or fungus has appeared on the apple trees, leaves becoming yellow and spotted;" "Tomatoes and potatoes blighting."

July 22d—"Less injury by insects and fungus."

July 29th—"Plums rotting on the trees."

August 5th—"Potatoes blighting and much affected by scab;" "Potatoes being blighted;" "Potato vines turning yellow and some rot showing;" "Plums rotting somewhat;" "Some blight appeared in tomatoes;" "Potato rot feared if present showery conditions continue;" "Asparagus rust spreading rapidly, both on old and new beds;" "Potatoes on low ground rotting;" "Apples dropping badly;" "Grapes doing well, very little rot;" "Sweet potatoes making too much vine;" Potatoes a heavy crop, but rotting badly; "Grapes doing well, no rot;" "White potatoes rotting in low fields."

August 12th—"Early potatoes being dug, some fields badly rotted;" A large crop of potatoes is being dug, some rot showing;" "Potatoes show indications of rot on wet land;" "Many tomato fields are affected by blight;" "Some potatoes rotting in low ground;" "Cantaloupes poor, vines scalding;" "Plums rotting on the trees."

August 19th—"Muskmelon vines have commenced to blight;" Plums and peaches both rotting;" "Only one case of rot in potatoes heard from, and that is in low, damp ground;" "Some rot in potatoes in wet ground;" "Potatoes show signs of rot;" "Some peaches rotted;"

"Asparagus rusting;" "Late tomatoes blighting;" "Many peaches have rotted on the trees;" "Peaches a light crop, early varieties cracking and rotting owing to excessive rains;" "Peaches, good crop, but frequent rains have caused much rotting;" "Corn in low fields scalding;" "White potatoes rotting in low fields."

August 26th—"Some potato rot;" "Potato crop heaviest in several years, but rotting in low ground;" "Peaches and plums rotting on the trees;" "Grapes out of danger from rot."

September 2d—"Potatoes rotting in places;" "Potatoes a large yield, but rotting;" "About one-third of the potatoes have rotted."

September 9th—"Potatoes in many places are rotting badly;" "Heaviest and finest yield of potatoes for years, no rot;" "Tomato blight severe, fruit dropping from the vines."

September 16th—"Potatoes all dug, some rot."

Temperature and Rainfall Since 1889.

The following table shows the temperature, in degrees (F.), and rainfall, in inches, for the present year, and the average for the past thirteen years since the Station was established:

Month.	Temperature. 1902.	Temperature. Average 13 years.	Rainfall. 1902.	Rainfall. Average 13 years.
January	28.4	29.9	3.28	3.66
February	27.4	31.4	6.24	4.05
March	43.9	38.4	4.34	3.89
April	50.2	49.1	3.62	3.42
May	60.3	60.6	2.04	4.50
June	67.5	69.7	6.57	3.54
July	73.0	74.0	4.78	4.96
August	70.1	72.5	3.91	4.21
September	64.6	66.3	5.65	3.68
October	56.0	53.9	6.39	3.68
November	49.3	43.5	2.20	3.99
December	31.7	34.3	7.23	3.39

In temperature, 1902 had a cold January and February, with a warm March, April and May, an average and cool June and August, with July somewhat below the normal. There was an excess of moisture in February and June, with a small rainfall in May and less than the average in July and August.

NOTES UPON SOME RUSTS AND MILDEWS AT WERNERSVILLE, PA.

While sojourning for health at Wernersville, Pennsylvania, during several weeks in the spring, some observations were made upon the parasitic fungi of that region.

Rusts.—Among the first of the rusts to appear was an *Aecidium* upon *Ranunculus abortivus.* This host is very common in the open woods, and the rusted plant is easily detected by the small, spade-shaped leaves, that stand up edgewise upon long, slender petioles. The diseased plants last for only a week or so after the cluster cups appear, thickly covering the under side of each leaf. The fungus seems to destroy all the portion of the plant above ground, and while, during one week, the display of rust is extensive, at the end of the next there is little left excepting dead leaves.

There were some small quince orchards in the region, and one in particular was bordered upon two sides by a hillside covered with cedar trees. In some instances the branches of the quince trees and those of the cedars interlocked. The cedars bore an abundance of the large, yellow galls commonly known as "cedar apples." These are the conspicuous formations of the rust fungus known as *Gymnosporangium macropus,* and in another form does much damage to the apple leaves and fruit. Upon the same cedar trees was an abundance of another species of *Gymosporangium* (*G. globosum*). This does not produce spherical galls like the one first mentioned, but causes a swelling of the small branches until they are somewhat spindle-formed, and become covered with an orange coating at the time when spores are set free. Upon the quince leaves, before they were full-sized, the rust appeared in considerable quantity, sometimes occupying all of the under surface when the numerous clusters of deep cups were produced. Later on the fruits probably became infested, for the mummy fruit of the previous year showed that the fungus had destroyed them. This *Roestelia aurantiaca,* as the orange rust of the quince is sometimes called, botanically, might be reduced by separating the two host plants of the fungus by cutting away the cedars near the orchards or exercising care in setting quince trees apart from the cedars.

The ash trees showed conspicuously the rust (*Aecidium Fraxini*) that is common to the species of *Fraxinus.* In the present instance some ash trees were entirely free, while others of the same species had

their leaves badly infested. This fungus works upon the leaf stalk in particular and causes it to twist into all sorts of fantastic shapes.

Wild roses, in some places, were so badly infested with a rust (*Phragmidium subcorticum*) that they were practically destroyed. This fungus, of an orange color, attacks the canes, as well as the leaves, and distorts and dwarfs them. This fungus was found in patches upon the untilled hillsides, while in other places the rose-bushes were free from it and healthy.

Among the herbs infested with a rust may be mentioned the sweet cicely (*Osmorrhiza brevistyles*), which is usually more or less affected with the *Puccinia Pimpinillæ* Strauss.

Mildews.—The *Peronospora Ficariæ* Tul., upon *Ranunculus recurvatus,* was quite abundant early in the season. Other hosts for same mildew were *Ranunculus abortivus* and *R. repens,* but it was most conspicuous upon the first-named crowfoot.

A chickweed (*Cerastium longipedunculatum*) was abundant in that region and badly infested with *Peronospora alsinearum* Casp. The mildewed plant usually remained small and produced no flowers. In some patches all the plants were diseased and dwarfed.

The tall figwort (*Scrophularia Marylandica* L.) showed the most conspicuous mildew, its large leaves being much discolored and sometimes distorted by the *Peronospora sordida* Berk. This is one of the mildews that produces a decidedly violet coating upon the infested part of the leaf, and, also, the border of the mildewed spot has a distinct purple border, as seen from the upper side. Some of the young plants were so badly infested as to be ruined.

The galiums were badly mildewed with *Peronospora calotheca* DeBy. It was most common upon the upright *Galium* Sp., where the whole plant was dwarfed and rendered of a pale color.

Many other fungi were met with, of which only one may be added here, namely, a smut upon Actea or Baneberry. This *Urocystis* infests the whole plant, from the base of the stem to the divisions of the large, compound leaf.

A large number of specimens of these various parasite fungi were secured for further study and distribution.

FUNGOUS ENEMIES OF PLANTS IN NOVA SCOTIA.

A trip was made into Nova Scotia for personal health. Five places were visited, namely, Halifax, Wolfville, Kentville, Digby and Yarmouth. Wolfville and Kentville are in the region of extensive fruit-growing, and particularly the orchard, crops. This is the home of the Gravenstein apple. Plums are grown quite extensively.

The following are some notes made upon the prevailing fungi infesting crop plants:

Apple—
Anthracnose of fruit or ripe rot (*Glœosporium fructigenum* Berk.).
Scab (*Fusicladium dendriticum* (Wallr.) Fckl = *Venturia inæqualis* (Cke.) Ad.).

Barley—
Smut (*Ustilago Hordei* (P.) Kell. & Sw., and *U. nuda* (Jens.) Kell & Sw.).

Bean—
Anthracnose (*Colletotrichum Lindemuthianum* (Sacc. & Magn.) Bri. & Cav.).

Beet—
Leaf-Blight (*Cercospora beticola* Sacc.).

Backberry—
Leaf-Spot (*Septoria Rubi* Westd.).
Rust (*Cæóma* (*Uredo*) *luminatum* Lk.; Syn. *Puccinia Peckiana* Hwe).

Catalpa—
Leaf-Spot (*Phyllosticta Catalpæ* Ell. & Mart.).

Cherry—
Black Knot (*Plowrightia morbosa* (Schw.) Sacc.).
Fruit-Mold (*Sclerotinia cinerea* (Bon.) Schrt.).
Leaf-Spot (*Cylindrosporium Padi* Karst. = *Septoria cerasina* Pk.).

Clover—
Leaf-Spot (*Phyllachora Trifolii* (P.) Fckl.).
Rust (*Uromyces Trifolii* (A. & S.) Wint.).

Currant—
Anthracnose (*Glœosporium Ribis* (Lib.) Mont. & Desm.).

Hollyhock—
Rust (*Puccinia Malvacearum* Mont).

Horse-Chestnut—
Leaf-Spot (*Phyllosticta sphæropsoidea* Ell. & Ev.).

Maple—
Leaf-Spot (*Phyllosticta acericola* Cke. & Ell.).

Oats—
Rust (*Puccinia coronata* Cda, and *P. Graminis* P.).
Smut (*Ustilago Avenæ* (P.) Jens, and *U. Levis* Kell. & Sw.) Magn.).

Peach—
Leaf-Blight or Shot-hole (*Cercospora Persica* Sacc).
Leaf-Curl (*Exoascus deformans* (Berk.) Fckl.).
Scab (*Cladosporium carpophilum* Thum.).

Plum—
Black Knot (*Plowrightia morbosa* (Schw.) Sacc)

Potato—
Leaf Mold or Early Blight (*Alternaria Solani* (E. & M.) Jones & Grout).
Scab (*Oospora scabies* Thaxter).

Quince—
Rust (*Gymnosporangium* sp., Syn. *Ræstelia* sp).

Rose—
Rust (*Phragmidium subcorticium* (Schrank) Wint., and *Ph. speciosum* Fr.).

Rye—
Smut (*Urocystis occulta* (Wallr) Rabh.).

Strawberry—
Leaf-Spot (*Sphærella Fragariæ* (Tul.) Sacc.).

Tomato—
Leaf-Spot (*Septoria* sp.).

Violet—
Leaf-Blight (*Cercospora Violæ* Sacc.).

Many specimens of nearly all the above species of economic fungi were collected, together with a large number of those upon weeds and wild plants. After further study these will be ready for distribution among the various centres of mycological investigation.

REPORT OF ENTOMOLOGIST.

REPORT OF THE ENTOMOLOGIST.

JOHN B. SMITH, SC.D.

GENERAL REVIEW.

No serious insect outbreaks were reported during the growing season of 1902, which was, on the whole, a favorable one for the farmer and fruit-grower. No new pests made their appearance, and even the old, well-known foes were conspicuous rather by their absence than otherwise. Some injury was done, of course; but there was no serious outbreak or widespread injury to any one crop. It was a season when the man who never sprays obtained nearly as good results as did those who always use insecticides when necessary. But such a season is usually one in which the enemy gathers in his forces, and while the prediction is not safe, I would not be surprised to find the season of 1903 marked by severe insect injury along several lines.

Plant Lice.

Scarcely a season passes that does not present some peculiarities in the distribution and relative abundance of plant lice, and the summer of 1902 was no exception to the rule.

Perhaps the most marked and unexpected occurrence was the absence of the *pea louse* until so late in the season that practically no harm was done by it, except to the very latest canning crop.

Mr. Asher Brakeley wrote on this point, June 18th: "The louse appeared on the early peas to a very small extent. No harm. Same, I believe, as to second earlies. On the late they are showing up in spots only—nothing like last year. I sprayed part of them early; but I am not spraying now, and don't think I will have to—they will go through without."

Somewhat later the insects became more plentiful, and some of the latest canning varieties were dwarfed. There was no complaint of late summer planting, and, altogether, practically no injury was caused. It would be unsafe to say that this marks the disappearance of the pest or even the beginning of the end. Conditions controlling abnormal insect increase are so little understood that we can make predictions only when a number of outbreaks have occurred.

Clover Lice became troublesome twice, as reported in the Crop Bulletin; but, unfortunately, no specimens were sent me, and I had no opportunity for determining what species caused the difficulty. As the pea louse lives on clover as an alternate food-plant, the possibility exists that this was a summer occurrence of that species.

Tomato Lice became noticeably abundant early in July, and for a week or two almost every mail brought in letters from Burlington, Camden, Gloucester or Mercer county, describing the infestation and demanding instant relief measures. A sample letter reads: "Please advise at once what to do for tomato lice. Have three acres which will be ruined unless given prompt attention." An even more urgent grower telegraphed his inquiry and asked a telegraphic response. One of the Commissioners wrote: "Our farmers have about 100 acres out in tomatoes and say these lice are killing them. Tell us what to do."

Whale-oil soap was recommended in each case; but as it is no unusual thing for this particular aphid to become rather plentiful in July, I suggested that no treatment be made unless immediate injury threatened. The fact that numerous Coccinellid larvæ and other parasites came in with every sending, made me feel safe in advising a waiting policy.

As I expected, it happened—the early crop was considerably injured; but, beginning about the middle of the month, the insects began to disappear. A letter, dated July 14th, reads: "I gave the whale-oil soap a trial and it killed the lice very successfully and did no apparent harm to the tomato. I did not go far with the soap, for I found the louse was leaving the tomato. I am satisfied, had I put the soap on a week sooner, I would have had much better vines now."

The reports were not confined to the counties already mentioned, but reached north as far as Hunterdon. The discouraging feature was that, while asking for a remedy, one grower stated that he had already applied Paris green, and another confessed to a failure from

a mixture of Paris green, wood ashes and plaster. The fact that stomach poisons can never prove effectual against plant lice seems to take a long while and many repetitions to become generally known.

Potato Lice appeared in some numbers near Moorestown about the middle of June and for a time threatened injury, but, as with the tomato lice, the threat was short lived—the insects disappeared and the plants recovered.

Apple Lice became locally plentiful in July, but no real injury was noted. There was a very general spread, however, until, in early October, sexed individuals occurred everywhere. In late October eggs were plentiful on susceptible varieties and there is promise for a heavy spring infestation at the date of present writing. Yet, an unfavorable turn of weather at just the right time next April may clear out almost the entire brood and leave the trees free for the season.

Melon Lice were observed in some numbers in Gloucester county in June, and for a little time the indications were for a disastrous season. But conditions changed, and, except on a few fields, no harm was done.

Strawberry Lice were kept in mind when examining beds from which plants were to be sold; but very little infestation was noted. These insects are serious pests in some more southern States, and strawberry plants are liable to inspection if introduced into them from New Jersey. I have therefore advised our growers to fumigate their plants in proper boxes before shipping them.

Peach Root Lice were credited with destroying a large number of young trees in Atlantic county and seriously retarding others. It is quite probable, from what I have observed, that this pest is much more common and widespread than growers appreciate. This is one of the pests on nursery stock that will be destroyed by fumigation, and that practice will tend to check their spread into new areas. Good feeding, to stimulate growth during the first two or three years, will give a large, healthy root system, capable of resisting ordinary attacks by these insects.

Lice on lima beans were several times reported, and, apparently, some local injury was caused.

The *Corn Root Louse* was obvious enough to cause visible injury, and I have reason to believe it did much mischief attributed to other causes. Some other species were referred to in the correspondence, but seem to have been of local importance only.

Altogether, this past summer was unfavorable to plant lice and correspondingly advantageous to the farmer. No widespread damage was caused on any crop except tomato, and there it was not serious. So far as remedial measures were employed, whale-oil soap proved itself most satisfactory, but it may be worth repeating that neither Paris green nor any other of the forms of arsenic is of the least use against plant lice of any kind.

Fall Web-Worm.

In recording the unusual abundance of this insect in 1901, I ventured the prediction that in 1902 it would, in all probability, be much less numerous and troublesome. This prediction was based, in part, upon observations indicating an increase in the natural enemies, and, in part, upon past experience with this same species.

The event justified the prophecy; but there was a period early in the year when it seemed likely to prove false. The early brood, in fact, was unusually abundant, and, in driving through the orchard districts of Monmouth, Mercer and Middlesex, in June, every plantation showed trees with webs; in some, indeed, almost every tree had at least one brood. So numerous did these nests become, and so generally distributed were they, that I deemed it wise to call attention to the matter in the Crop Bulletin, recommending energetic action to destroy them.

But before the larvæ were full grown they began to die off and few of them ever reached the pupal stage. Moths from this brood of caterpillars were very scarce, and, after midsummer, scarcely a web or nest was to be seen. The fall web-worm has been put back by nature's own methods into a position that will make injury from it unlikely for at least two or three years to come. This effect was not local or in any way confined to restricted areas—it was universal and effective—amounting to practical annihilation for millions of caterpillars within a few days.

The Vaporer Moth.

The experience with this species was somewhat different from that with the fall web-worm, because this form made practically no show at all early in the season. Of the myriads of larvæ that spun up during the fall of 1901, comparatively few matured; yet enough to produce egg masses in great number. But the eggs did not hatch, or

the young larvæ died; in any case, what remained did no appreciable injury and attracted no attention. The second brood was much more in evidence, and, locally, even abundant, so that there is a possibility that, during the summer of 1903, the species may become as troublesome as it is in ordinary years.

Orchard Insects.

Quite a marked feature was the comparatively small number of codling moth and plum curculio in the orchards at large. There were localities where the curculio was as bad as it could well be, but these were rather exceptional. So, wormy apples were scarce, even where no spraying was done, and there was an unusual proportion of fair fruit everywhere. But the insects were by no means absent, and there is danger that, should next year's crop be in any way shortened, the insects will be found sufficient to annex it. The careful fruit grower will be especially thorough in his spraying work next spring, while the careless grower will, banking on his escape this season, trust to luck once more, and probably lose by it.

Other orchard insects were also rare, and fruit growers had, on the whole, as favorable a season as could well be wished for.

Strawberry Weevil.

A few complaints were received of injury to strawberries in Burlington county, in which this insect was recognized as the author; but many more were made in such terms as to show that the fruit grower had failed to recognize his enemy. From such information as I was able to gain, it is probable that, locally, the crop was reduced by fully one-half. Areas of injury extended into Burlington and Cumberland counties and probably other localities were more or less affected, though not reported.

It is well that this insect does not often become very abundant, because its habits are such that we cannot reach it with insecticides.

Rose-Bugs.

These insects continue to increase in certain parts of the State and do considerable damage to fruits and flowers. They seem to be preparing for another period of abundance, such as was in progress in

1890 and 1891, but have not yet reached anything like that stage. Nothing has been added to our batteries that enables us to kill the insect any more rapidly than we could in the past, and collecting in kerosene pans is yet the most reliable method of doing away with it.

Vineyards have not yet been attacked to any extent, but in gardens grapes have, in some places, suffered severely. In such cases bagging may be resorted to with satisfactory results, and, where only a few fruit trees are to be protected, the Bordeaux mixture is of considerable advantage. Paris green acts slowly, and, while it kills the beetles in time, does not prevent injury.

Grain Insects.

Grain farmers have suffered severely for some years past, less from the Hessian fly, perhaps, than from the Angoumois grain moth: the former being more troublesome in the northern parts of the State, the latter destructive to the south. In each section practice is adapting itself to conditions—late seeding in the north—early threshing in the south. This year the early cold snap induced dangerously early seeding in many places, and it would not be a matter for surprise if the summer of 1903 developed more injury from Hessian fly in North Jersey than for the two or three years last past. Normal seeding time in South Jersey is usually late enough to avoid injury.

Rose Scale.

This insect has been under observation for some years, but it had not been classed among the positively injurious species until within the year or two last past, when it became troublesome on blackberry and raspberry bushes. The material accumulated from previous observations was supplemented by a series of experiments and studies made by Mr. Henry Pfeiffer, of Cologne, and Mr. E. L. Dickerson, under my direction. The results were embodied in Bulletin No. 159, which was sent out in July.

That it was timely was indicated by several communications; notably one from Elmer, in August, in which it was stated that "your remedy for the rose scale was tried and proved very successful."

Periodical Cicada.

The occurrence of Brood XXII. of the periodical cicada during the arly summer made it possible to study its distribution more carefully han had been previously done. All of the broods scheduled to ap-ear in New Jersey have now occurred since my connection with the Station, and this is, therefore, a good time to present a general review f the observations made on them and a map illustrating their general listribution. All this is given on a later page, without any attempt t a complete life history, which has been given in previous reports nd bulletins.

Oak Pruner.

An unusual number of dying twigs in oak woods and on isolated rees was noticed during the late summer and a few inquiries were received. In looking out for signs of cicada, these dying twigs were sometimes so plentiful as to raise a momentary doubt concerning the cause.

The oak pruner is a round-headed borer that lives in the small branches or larger twigs of oak trees. When it becomes nearly grown it eats from the inside until the wood is cut almost through, and the first high wind will cause the girdled shoot to break and fall. The larvæ remain in the cut end and fall to the ground, completing their transformations in the dry stick. In the forest the injury amounts to a harmless pruning only; on shade trees the injury is more marked, and the fallen twigs and branches should be gathered and burnt to prevent the larvæ contained in them from coming to maturity.

IMPORTED MANTIDS.

In the report for 1901 I stated what had been done in the way of distributing egg masses of the European praying mantids and the allied Chinese species. As the character of the insects and the object of bringing them into New Jersey were there explained, nothing need now be said on these points. Except at New Brunswick, no insects were found as the result of the settings out. At Burlington I had a chance to look over the area in which the egg masses had been distributed the year before and no traces of the species were observed. At New Brunswick I found several egg masses of the Chinese species

during the winter of 1901–1902 within 500 feet of the point where I set out the cases in the spring of 1901. It was proved, therefore, that the insects could live over at this point.

In April, 1902, I received another lot of egg masses of the European species from Professor M. V. Slingerland, collected in Northern New York, and a fine lot of cases of the Chinese species, taken near Philadelphia by Mr. Philip Laurent.

The eggs of the European species were divided between Mr. H. W. Collingwood, editor of the *Rural New Yorker,* who tied them out on low shrubs at Woodcliff, N. J.; Mr. Hiram T. Jones, who put them out near Elizabeth, and Mr. E. L. Dickerson, who placed them near Newark and near Arlington.

Nothing was seen of any adults from any of these plantings. Mr. Collingwood reported having made an examination, finding no signs of hatching, while some cases had been picked open—perhaps by birds. Mr. Dickerson went over the ground stocked by him in the early fall of 1902, but found no trace whatever of insects. Egg masses were found yet tied in place and from these the insects seemed to have emerged in part.

The egg masses of the Chinese species were divided between Mr. Charles Black, at Hightstown, Mr. Charles B. Horner, of Mount Holly, and Mr. E. L. Dickerson. Mr. Black and Mr. Horner each placed the eggs on their respective farms, and Mr. Dickerson divided his between the vicinity of Newark and the vicinity of Arlington, in territory adjacent to that in which the European species had been distributed. From all of these plantings adults were reported, directly or indirectly. Messrs. Horner and Black both sent me examples of the adults, absolutely proving their occurrence, while the Arlington specimens were reported by Mr. Wm. Beutenmuller, of the American Museum of Natural History.

In early October several specimens, male and female, were noted in the Experiment Orchard at New Brunswick, but there seems to have been no disposition to spread to other places.

Mr. L. H. Joutel, of New York City, informs me that he put out several egg masses of the Chinese species near Fort Lee, and that some of these hatched.

The insects have now a fair chance for life in several localities, and, if they will do well with us, should be found in some numbers next year.

Grape Insects.

The Grape leaf-hoppers have been unusually abundant this year, and, in some places, have very materially affected the crop. Almost everywhere they have browned and dried the foliage, causing it to drop much sooner than it would otherwise have done. In New York State the matter was much worse, as I am informed by Professor Slingerland, of the Cornell Experiment Station, and the crop there was very seriously shortened. The life history of the insects and the best method of dealing with them will be published by the New York Station.

Another grape insect came to hand late in 1901, but was not identified in time to be referred to in the report for that year. It is a leaf-roller, from the Egg Harbor district, where it was said to do considerable damage. The larvæ that were sent me pupated and developed adults in the spring of 1902. They proved to be *Desmia funeralis* Hbn., a species which is rather common throughout the State, but has not been troublesome before in my experience. It is not likely to become more plentiful or more than locally injurious.

Elm Leaf Beetle.

This insect has been more abundant during 1902 than for several years past, and has disfigured trees in cities and towns that had been little troubled of late. At New Brunswick the heavy sleet storm of February, 1902, broke so many branches of the larger elms that they were badly mutilated to begin with. The foliage was irregular and scant in consequence, and the beetles were much more concentrated upon it than would have been the case under normal conditions. Injury was therefore more obvious than usual, in spite of the sprayings that were made.

At Newark and in its vicinity the pupæ were attacked by a fungus disease similar to that which attacked the insects in the same stage at New Brunswick in 1896. So general was this infection that the indications are for a very light brood at Newark for 1903. At New Brunswick the disease was not observed.

Cabbage Insects.

Cabbage-worms have not been nearly as abundant as usual and I have seen very little signs of damage anywhere. But the beautifully striped and banded larva of *Mamestra picta,* which belongs rather to the cut-worm tribe, was more common than it is ordinarily. It was not confined to cabbage, but was sent in from a great variety of plants. Cauliflower was among those attacked, and one of my correspondents said that, while they occurred in patches only, the plants were literally covered. The feeding in colonies is rather a habit of this species; those hatched from the same batch of eggs remaining together until they are nearly full grown. For remedial measures, the arsenites answer every purpose, and the resin-lime mixture is, on the whole, the best of them.

An insect very rare as an injurious form in New Jersey is the cabbage weevil; but this made its appearance near Moorestown in numbers sufficient to attract attention. According to my correspondent, "they seem to eat in the heart and inside leaves, doing some damage, but not much as yet." Fortunately they did not increase, and the question of remedial measures did not arise.

Sometimes it happens that an insect primarily injurious to a field crop modifies its habits so as to enable it to attack one grown under glass. Of this type is the little "diamond back moth," *Plutella cruciferarum.* Its natural food plant is cabbage, but it has adopted the "wall flower," which belongs to the same natural family, as an alternate, and becomes troublesome in greenhouses in which these plants are grown. In the fields little is seen of the insect, and during the winter it is not very active; but when the sun gets higher, in spring, it multiplies and injury becomes serious. The free use of pyrethrum seems to have proved the most effective method to keep this pest in check under glass; in the garden or field I have seen no case that required serious attention.

San Jose Scale.

Nothing was added to our knowledge of the habits or life history of the pernicious scale from this department. Most of the work done with or because of it was in my capacity as State Entomologist, and only the matter of insecticides for its destruction received especial attention. There may be found, even yet, fruit growers who are con-

vinced that the injurious character of the insect has been unduly magnified and who will not be persuaded to attend to their infested trees. But they are now in the small minority, and experience has shown that it is better to allow such men to go their own way, since the life of infested trees is very short and their death removes the source of spread. With the general recognition of the danger from the insect, with the adoption of the remedial measures now at hand, and with care exercised in the distribution of nursery stock, we may fairly say that we are at the beginning of the end of the scale dominion.

Chinese Lady-Birds.

In the fight against injurious insects the matter of natural enemies has of late years assumed an important place. When the insect to be dealt with is a native species we are practically helpless, for nature itself has in that case established a balance which is not easily changed. Where the injurious species comes from some other country the matter is different, and it is always important to know whether in its natural home the insect is as troublesome as it is in its new domain. If it is not, we are put upon inquiry to ascertain why this difference exists, and, if the check in the old home is some parasitic or predatory form, whether we cannot bring this to our aid.

So, the question of a natural enemy to the San Jose scale has been before us for years, and, in my previous reports, this point has been more than once touched upon. A special trip to California on this behalf proved fruitless; but not without benefit in the matter of information obtained.

The main trouble was that we did not really know where the pernicious scale actually was at home and our experiments were, of necessity, somewhat haphazard. During the summer of 1901 Mr. C. L. Marlatt, of the Division of Entomology of the United States Department of Agriculture, spent some time in China and Japan and discovered that, without reasonable doubt, northern China is the native home of the insect and that it is there kept in check by a beetle of the Coccinellid or lady-bird family. Some of these beetles were sent to Washington and enough of them survived to start breeding in the spring of 1902.

By the courtesy of the Department some of the insects were sent to me and were placed in cages covering scale-infested trees. Details of this experiment are given in another part of the Report.

Crude Petroleum.

No specific experiments were made with this material. Its range and the method of its application have been again and again repeated, and, despite some bad results, its use has been steadily extended. It has been found that while it may not be always safe when applied in one way, it may be used in another with excellent effect. The material is now really in the hands of the fruit growers and their experience must decide its range and usefulness. Its value, as compared with the lime, salt and sulphur wash remains to be fixed, and it will be found, I think, to have a field that the other cannot fill. Tests have now been made in many localities, and, while it is rarely recommended for use undiluted, the mechanical mixtures or emulsions are ever more effectively employed. On another page this subject is again referred to, somewhat more at length.

The Lime, Salt and Sulphur Wash.

In the records of the Experiment Orchard there will be found a number of references to sprayings made with "Calcothion," which is in effect a ready-made lime, salt and sulphur wash, in condition to apply without further preparation. It was used to determine, in part, whether it was really good for anything and, in part, assuming its composition to be practically the same as that prepared by the farmer from the ordinary formula, whether the application made cold would give the same results as when applied hot.

The recommendation to "apply hot" is not so easy a one to follow, for, even if your mixture is so hot as to require a guard to enable one to hold the spray rod comfortably, yet, by the time it gets through the nozzle as a spray, to the branches of a tree only ten feet away, there is very little heat left in the particles. If the outside temperature at all approaches the freezing point, a temperature over 70° will be practically impossible. Through a Vermorel nozzle the material is forced in particles so small that three feet away boiled water is reduced to the temperature of the air. On this point I speak from experience gained in a series of tests made with hot water as an insecticide for rose-chafers.

If high temperature at the point of contact is, therefore, essential to the action of the insecticide, much imperfect work must result and the effectiveness of the wash must decrease as the point to be reached

becomes more distant from the nozzle. Trees thirty feet high, and as much in diameter, which is not unusual for old apples, could never be covered, from any ordinary spray nozzle, with "hot" material. Nor could spraying be done on even much smaller trees on very cold days or when there was any wind at all, for this would absorb heat too fast.

Practically, the Calcothion,* applied cold, was quite as effective as any lime, salt and sulphur application made anywhere in New Jersey. For details, the record of the Experiment Orchard should be referred to; but, roughly stated, all the areas to which it was applied were cleared of scale and remained clean until late in the season. It adhered much better than whitewash and could be readily noticed two months after the application. The material was received too late to be applied to entire trees without serious injury. They were already in practically full foliage and the experience was that every leaf wet with the mixture was killed. On peach, the entire shoots were killed, and, in some cases, no further growth was made from these points. Hence, no tree was entirely cleared of scale by the mixture, and areas clean in midsummer showed re-infestation in fall.

While testing the "Calcothion," a number of other trees were treated with lime and salt only—really an ordinary whitewash, with considerable salt added to increase its sticking qualities. This was applied with a brush to the trunk and branches to determine its lasting qualities and, incidentally, its effect upon the scales. It proved much less resistant to the weather, and the coating quickly became imperfect. On smooth trees, especially, its life was short; but on rough, scarred bark it remained noticeable until midsummer. No great effect was produced upon the scales, but the coated areas were avoided by the larvæ. On the rough-barked trunks very few insects set; but this was probably as much due to the mechanical condition of the bark as anything else.

Bulletin No. 162 was prepared at the end of the season to summarize the results obtained and to serve as a guide to fruit growers for winter applications. The matter presented in that Bulletin need not be repeated here; it is sufficient to say that information gathered from all sources, within and without the State, indicates that the lime, salt and sulphur wash, properly prepared and properly applied, is an effective destroyer of the pernicious scale and is more safely applied to sensitive trees, like peach, than the mineral oils.

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* **Adler Color and Chemical Co., 100 William street, New York City, N. Y.**

The formula most generally used in New Jersey is:

Flowers of Sulphur	**50 pounds.**
Stone Lime	**50 "**
Stock Salt	**50 "**
Water	**150 gallons.**

Slake the lime with hot water, add the sulphur and boil for at least an hour, adding water, from time to time, as needed to keep the mixture sufficiently fluid. Then add the salt, and, when that is dissolved, boil for at least fifteen minutes more, adding hot water to make up the 150 gallons. The product, if the boiling is thoroughly done, is a double sulphide of lime, is very caustic and should be strained before using.

Shell lime may be used instead of stone, if more convenient, and the amount of salt may be somewhat reduced without harm. The formula, as it stands, is easily remembered, since it only requires equal parts of lime, salt and sulphur, no matter what quantity is used, and the amount of water is always three times as many gallons as there are pounds of sulphur.

The salt may be replaced by blue vitriol, four and one-sixth pounds of the crystals equaling the fifty pounds of salt. The cost is about the same and the mixture is said to be rather more quickly effective. If the blue vitriol is to be used, the crystals should be dissolved in water and the solution added slowly to the boiling mass of lime and sulphur.

The wash may be applied through any apparatus that will properly spray the Bordeaux mixture and must be thoroughly applied to be effective. Its corrosive character has been already referred to, and pumps, nozzles and other machinery should be thoroughly washed and oiled after using it.

In the peach orchard this material is much safer than crude petroleum and will probably replace it. I doubt whether it equals the oil for other trees, and it cannot entirely replace that product when bad infestations are to be dealt with. In the year's experience in Georgia, this wash stands third, with crude oil in emulsion or mechanical mixtures in the lead.

Thorough application of the sulphur wash must be insisted on, since it kills only what it hits and does not spread like oil or soap solutions. The cost of the wash for materials alone, irrespective of

fuel or the labor of preparing it, is between one and one-half and two cents per gallon.

For other details, Bulletin No. 162 should be consulted.

Other Insecticide Tests.

Almost each year samples of insecticides are sent in to be tested; sometimes evidently for advertising purposes, sometimes by makers who are really trying to get up a meritorious mixture for a specific purpose. It is not always possible to make these experiments under satisfactory conditions, and some of the substances are obviously out of court owing to the price demanded. Where a responsible firm attempts to make a standard mixture it does not hesitate to give the character of the materials used and the other facts necessary for an intelligent test of its insecticide value, and for them I make such tests whenever possible.

Three mixtures only were tried this past season—"Calcothion," "Agricultural Soap" and "Black Soluble Insecticide Soap." The first and second were experimental preparations sent in to be tested before being regularly placed upon the market. The third was already on the market and was supposed to be a "gold medal" substance, greatly the superior of anything heretofore known.

All of these were tried in the Experiment Orchard, and the record given on another page should be referred to for the results obtained.

Fumigation.

This subject is becoming of ever greater importance to the nurseryman, as the spread of the pernicious scale demands ever greater care on his part in selecting the stock to be sent out to purchasers. It is of importance to the farmer, because stock properly fumigated comes to him free from many of the pests that are apt to attach themselves to young trees in nursery rows. But fumigation is a process and not a mere word; like everything else, it can be done properly and effectively, or improperly and ineffectively. I have referred to the subject in several of my reports, but have never given it a place in New Jersey orchard practice. Nor have I changed my views on this point, but am impelled to go into the subject somewhat more in detail on a subsequent page, because in this process and its effect lies the only real protection against the distribution of infested nursery stock.

Inspections.

The work of the State Entomologist increases as the pernicious scale continues to spread and fruit growers in the late-infested localities awaken to the danger. Had I accepted all the suggestions made to me of places to be visited it would have taken nearly my entire time for the year. Several trips were undertaken so as to spend an entire day inspecting the orchards of one district, and, in a number of cases, informal field meetings were held, at which I was able to demonstrate to those in attendance the character and injury caused by the scale and the manner in which it caused the mischief complained of.

The general interest thus awakened reacts upon the nurseries, and it has become practically impossible to sell stock uninspected and not certified as clean. The consequence is that this department is called upon more frequently than ever to inspect the small nurseries growing only single blocks of trees for sale, which in the past paid no attention to either the requirements of the law or the interests of those who bought from them. The number of letters of inquiry from would-be purchasers is also increased, and, again and again, questions come as to whether this, that or the other nursery is a safe one to purchase from.

It has always been the policy of this department to assist nurserymen just as far as possible, consistent with the interest of those that purchase from them; hence, nurseries have not only been more closely inspected than ever before, but inspections have been made at times when, under the State law, the nurserymen neither desired nor were entitled to them. Despite the utmost efforts of their owners, nurseries in some sections of the State are so situated that infection to a greater or less extent is almost unavoidable, and the problem has been, not only to keep out the scale so far as possible, but to destroy such as may come in despite the precautions observed. To this end nearly all the nurseries are now provided with fumigating houses, and I have been at great pains to impress upon the growers the importance of careful and thorough treatment of the stock. Other States are making their inspection laws more rigid than ever before, and their enforcement is placed upon a much more effective basis. Adequate appropriations are made, sufficient, in many cases, to make a real police inspection possible, and, as in New York, for instance, to

ep inspectors in the field during the entire year, with ample wers to enforce their decrees. In that State any certificate is cepted, and even stock without certificate is admitted. But once is delivered within the State, it is closely examined by employes the State Department of Agriculture, and, if on any consignment y appearance of scale is found, the doubtful trees are destroyed d all the others are fumigated, whether they had been previously sub-itted to this process or not. If scale is discovered at all, the infested ee is destroyed without attempt to discover whether the insect is ad or alive. In this stand, New York approaches the Californian actice, and it is a question whether, after all, this is not the real lution of the whole problem. If each State would simply tend to atters within its own borders and destroy all infested trees brought , it would not be long before nurserymen from without its bound-ies would become very cautious as to the character of the stock they ipped. As matters stand at present, New Jersey has very little al protection against infested stock from other States and none at l against the distribution of infested stock grown within its own rders. The appropriation made to the State Entomologist suffices pay traveling expenses and part of the salary of an assistant who akes inspections, but no more. The Entomologist himself gets no mpensation, and the duties imposed upon him are in addition to ose which he owes to the Experiment Stations and to the Agricul-ral College, from which he draws a salary. The Insect Commis-oners are active within their jurisdictions, but they can act only on mplaints and have no power to incur expense. It is not only in ew Jersey that conditions begin to approach the intolerable, and, meetings of the official inspectors, held at Washington, in Novem-er, 1901, and Atlanta, in October, 1902, the whole subject was thor-ughly discussed. An organization was effected whereby each in-ector who meets infested stock from States other than his own otifies the official concerned of his discovery and puts him in posi-on to trace the source of the infestation. Nevertheless, the whole ibject is in an unsatisfactory state, and a committee was appointed the chairman at the Atlanta meeting, to which was intrusted the sk of studying conditions as they exist under present laws and to commend such legislation as would seem desirable to conduce to niformity of practice in interstate commerce.

The mandatory powers of the law within State limits have not

been applied in any case during the past year. It is realized that persuasion accomplishes more in the long run than attempts at compulsion, and, therefore, I have always tried to prove the necessity for active measures from the standpoint of self-interest for the grower concerned.

Collections.

No important single additions were made to the collections, but a great many specimens were added in the course of the year from gatherings made by Mr. Dickerson and myself. Several cases have been arranged, and scientific study has been made of one group among the owlet moths. A number of boxes were prepared for the State Museum, at Trenton, and thirty-five are now on exhibition. The collections of the Department, belonging partly to the College and partly to the Station, have become of really great importance and value, and deserve a safer housing. The scientific value of the types alone is very great and the study value of the collection is difficult to estimate in terms of money. In certain families of the moths, the collection is unsurpassed by any in the United States.

Miscellaneous.

During the summer I attended the meeting of the Association of Economic Entomologists at Pittsburg, and, in the general discussion, became familiar with what was doing and what had been done in other States. The chief subjects for discussion were the pernicious scale and the periodical cicada, but other topics of economic importance were not wanting, and the meeting was a very profitable one from all points of view.

My connection with the entomological societies at New York City, Brooklyn, Philadelphia and Newark has been maintained, and, as usual, I have received information that has been of use to me in my work, from the individual members.

To the Division of Entomology, in the United States Department of Agriculture, and to the gentlemen on the staff of that division, I am indebted for information and for assistance, as is specifically acknowledged elsewhere.

Formal lectures, informal talks and addresses have been delivered at indoor and outdoor meetings of farmers, before clubs, at picnics,

arvest homes and at county board and institute meetings all over he State. To many hundreds, direct information has been brought n topics of present interest to them, and the results are slowly be-oming apparent in the more general adoption of better practice.

Addresses have been also made before the State Board of Agricul-ure and before the State Horticultural Society, at their annual meet-ngs, on topics relating to my Department.

The correspondence of the Department is greater than ever before. At least 3,000 separate communications are recorded on 2,000 pages of etter books, and this does not include circular letters to commis-ioners, board of health officers, etc.

During most of the year I have had the assistance of Mr. E. L. Dickerson, who has acted as my deputy in making nursery inspec-ions and has relieved me of much manual work in the Laboratory.

EXTRACTS FROM THE CROP BULLETIN.

The season began April 30th, with my request for records on the appearance of the periodical cicada, and, as this subject is covered elsewhere in this report, no further reference to the matter will be made under this heading.

San Jose Scale has the honor of the first record, from Fairlawn, Bergen county. At Freehold, Monmouth county, some trees were said to be injured; at Franklin Park, Middlesex county, many trees are affected, and at Martinsville, Somerset county, farmers were "spraying for the San Jose scale." Four records for the first number of the Crop Bulletin indicate a much more general interest in the subject than in the past.

May 6th the insect was reported from Beverly, Burlington county, as damaging apple trees. May 12th, it was recorded from Paterson, Passaic county, that the scale had appeared in abundance. Not until June 24th was the insect again referred to and then from Martins-ville, Somerset county, where it was injuring fruit trees. August 15th, Mr. Beans reports from Moorestown, Burlington county, that in the peach district this insect had injured many trees. This ends the record, which is rather scanty for the most destructive species occurring in the State.

Tent Caterpillars were noted on apple trees as early as April 30th, at Kingwood and Rowland's Mills, both in Hunterdon county. May 6th, they were very numerous at Ocean View, Cape May county.

May 12th, they had made an appearance at Pittstown, and were troublesome at Rowland's Mills, both in Hunterdon county. May 20th, they were unusually troublesome at Huntsburg, Warren county, and their appearance was noted at South Bound Brook, Somerset county. May 27th, they were more numerous than usual at Kingwood, Hunterdon county. June 3d, some trees were stripped of their foliage at Huntsburg, Warren county, and at Frenchtown, Hunterdon county, they were troublesome. This is probably the last record referring to the real tent caterpillars, and later reports, under the same general terms, apply almost certainly to the fall web-worm.

A few *web-worms* were noticed, June 17th, at Freehold, Monmouth county. July 1st, they were troublesome at Kingwood, Hunterdon county, and numerous at Cape May, Cape May county. July 8th, they were quite numerous on the fruit trees on the College Farm, at New Brunswick; they were injurious to such trees at Farmingdale, Monmouth county; were numerous at Hightstown, Mercer county; numerous and destructive to fruit trees at Salem, Salem county, while at Moorestown, Mr. Heritage states, they were abundant, and that not enough spraying was done to destroy them. July 15th, they were bad on fruit trees at Egg Harbor City, Atlantic county. August 19th, they were numerous at Ocean City, Cape May county, and this was the last record of the season, as well as the only one that probably refers to the second brood. The first brood became so abundant in late June that in the Bulletin for July 1st I inserted a note cautioning fruit growers to keep a lookout for a possible dangerous increase later on.

"*Potato Bugs*" were first reported May 12th, from Farmingdale, Monmouth county, and were already troublesome at Sewell, Gloucester county. May 20th, they were troublesome on the early potatoes at Rocksburgh, Warren county, and on June 3d they were so at Frenchtown, Hunterdon county. June 17th, they were reported from Cranford, Union county, and July 1st they attracted attention at Ardena, Monmouth county, and at Frenchtown and Kingwood, both in Hunterdon county. This ends the season so far as this insect is concerned, and reports are altogether less numerous and injury is less complained of than usual.

Plant lice were troublesome on some crops, and the first to be noted is the *apple louse,* which affected some orchards at Mickleton, Gloucester county, May 12th.

Plant Lice on tomatoes were first reported from Sergeantsville, Hunterdon county, June 3d, as doing some damage. Not until July 8th was there another complaint and then it came from Woodstown, Salem county, where the late tomatoes were said to be fair, except for this infestation. July 15th, Hightstown, Mercer county, reports tomatoes as badly infested, and at Swedesboro, in Gloucester county, the insects were doing much injury. July 22d, injury was reported from Medford and Mount Holly, both in Burlington county, and on the 29th of that month, Clayton, Gloucester county, and New Egypt, Ocean county, made complaints to the same effect, closing the season so far as this insect is concerned.

Plant Lice killing clover, in places, was reported from Mickleton, Gloucester county, June 17th, and on the 24th, South Bound Brook, Somerset county, places the loss from these insects at two-thirds of the entire crop.

Plant Lice on melons were noted at Mickleton, Gloucester county, June 17th, and not again until August 5th, from Landisville, Atlantic county. In neither case was specific injury claimed.

Root Lice on corn were reported once only—July 1st, from Layton, Sussex county.

Lice on lima beans were very troublesome at Trenton, Mercer county, July 15th, but, apparently, attracted attention nowhere else.

The most satisfactory record came from Freehold, Monmouth county, August 12th, and read: "Very few plant lice this year."

Currant and Gooseberry Worms appeared in troublesome numbers at Flemington, Hunterdon county, May 20th, but seem not to have been abundant elsewhere.

Cut-worms were first reported cutting cabbage and tomatoes, May 20th, at Clayton, Sussex county, and on June 24th they were damaging corn, tomatoes and garden truck at Salem, Salem county—a very brief record for these insects.

Rose-bugs were numerous at Cape May Court House, Cape May county, June 10th, and "very destructive" at Ocean View, in the same county, on the same day.

The *Curculio* is credited with injuring fully half the apple crop at Cold Spring, Cape May county, and is not again referred to.

The *Codling-moth,* also, is reported once only, as causing apples to drop at Martinsville, Somerset county.

Asparagus Beetles, or rather their larvæ, were numerous and causing damage at South Bound Brook, Somerset county, July 22d.

Cabbage-worms were abundant enough to be troublesome at Kingwood, Hunterdon county, August 12th.

The *Angoumois Grain Moth* was reported as threatening the entire wheat crop at Shiloh, Cumberland county, July 22d.

In the last Bulletin of the season, September 16th, Somerville, Somerset county, reports "no winter grain sown yet for fear of the Hessian fly," but this stands out against numerous other reports of seeding completed or in progress.

A very general report came from Readington, Hunterdon county, July 8th, that corn is "growing, where not eaten by insects."

From Beverly, Burlington county, we learned, July 15th, that there was "considerable spraying done," but of what sort is not stated.

Altogether, based on the crop reports, this season seems to have been remarkably free from serious insect troubles.

THE EXPERIMENT ORCHARD.

No detailed record was made in the report for 1901 of the work done on the trees grouped under the above term. For various reasons it was deemed best to bring together all the work previously done into bulletin form, giving suggestions, incidentally, as to methods of dealing with the common orchard pests.

During the past summer the trees have been somewhat neglected and some of them have become very scaly. Others of them were so close to the fence adjoining the street or the College athletic grounds that the fruit attracted the attention of those members of the boy tribe that consider natural products free for any who can take them. The trouble so caused induced me to take out a number of the peach trees and no others were set to replace them. Nevertheless, some observations were made and some experimental work, chiefly with lime mixtures, was done which merits record. As it is also intended to test the "Calcothion" rather carefully during the coming winter, the present condition of the trees is a matter of importance. The records begin where those in Bulletin No. 155 end, unless it is necessary to explain an existing condition from a previous happening.

General Notes.

An examination to determine the general condition of the trees was made March 30th, after a heavy rain; another, to determine the stage of the blossom buds, was made April 16th, and a more general inspection was made April 18th, after a period of warm weather. April 21st, the trees which had blossoms were noted, and on the 22d, 23d and 30th other notes were made, the weather being decidedly warm and rather dry. The first week in May continued warm, with some rain, but the temperature dropped after the 8th, and for three nights before the 12th approached the frost line. The weather remained cool until the 16th and 17th, when I applied a dressing of mixed fertilizer samples on all except trees 37 to 40, inclusive, forking it in for a distance of from two to three feet from the trunk. A little period of warmer, cloudy weather followed, and on May 23d, a cloudy, sultry day, I whitewashed the trunk and base of the larger branches of trees 12, 14, 15, 16, 17, 18, 19, 20, 21, 26, 28, 30, 35 and 43. The whitewash was of good body, heavily salted, and was applied with a brush. Then came a series of heavy showers and, before June 1st, one day of solid rain; all of which sadly marred these lime coatings.

June 9th, sprayed apple, plum and walnut with arsenate of lead to check web-worms, and on the 11th sprayed the pears as well. On the 22d, developing nests were seen on trees 5, 15, 16 and 38, and these were again sprayed with arsenate of lead. No care was used in getting this arsenate of any particular strength, but it approached very close to one pound in ten gallons of water, and is so referred to.

Black Insecticide Soap

July 5th was a hot, sunny day, and I applied "black soluble insecticide soap" to trees 4, 5, 12, 19, 32, 36, 39 and 42. This soap has been quite well advertised, and the makers or importers claim for it a European reputation, as well as a gold medal gained in competition with all other insecticides, at some Italian exposition. They have been persistent in their efforts to secure an endorsement of the material and claim that it kills scales, plant lice, the leaf rollers of the vine, etc.

A small keg of the soap was purchased, and on the afternoon of

July 4th I dissolved it according to directions and let it stand until next day. The solution was made much stronger than recommended, and, when diluted for application, trees 4, 5 and 12 received one pound in about seven gallons of water, and the others, one pound in about six gallons of water; both much stronger than recommended. I used no more concentrated mixture because I feared possible injury to the foliage. Every tree was sprayed to a drip from two sides quartering the wind, and, so far as possible, against it. The fruit was as thoroughly drenched as the foliage and I doubt whether anything escaped a wetting. No benefit could be observed, when examinations were made during several days, and I could not be sure that even a single active larva had been killed. At all events, they became so numerous that, after a general inspection made July 12th, I sprayed trees 4, 12, 38 and 39, on a hot, dry morning with the soap at the strength of one pound in two gallons of water, with exactly the same results as before.

I notified the dealers of my results and received expressions of surprise and fear that I must somehow have received a lot of material that had long been made up and had deteriorated; they would send me another fresh lot for further trials. They did send it, and on July 28th I sprayed trees 19, 21 and 39 with a mixture of one pound in two and one-half gallons of water. No good effects were noted yet. On August 10th I used one pound in two gallons of water on trees 17, 18, 19 and 21, making the applications very thorough on all except tree 17, which received a short dose because the material gave out.

This is about the least effective material I have ever tested and is about as little harmful to the insect as it is to the trees. The price is as high as the stuff is ineffective, and all persons desiring to buy a real insecticide should avoid Cassaza's black soluble insecticide soap.

Agricultural Soap.

Another material received for trial was an "agricultural soap" made by a good firm for experimental use. The material was soft, dissolved rather readily in hot and rather slowly in cold water. Applied it June 24th on apple and pear and found it more of a task than I had bargained for. Evidently there was resin in the mixture, and before long, nozzles, valves, stop-cocks, etc., were all glued fast

and could scarcely be stirred. Hose, spray-rod and pump handle became so sticky that care was required lest, in letting go any of these, a piece of skin be left behind.

Before I could use the machinery again it was necessary to take everything apart and wash in hot water to remove all trace of the soap. When I notified the makers they agreed at once that such a material was better kept off the market.

As to the effectiveness of the soap there was little chance to form a judgment, because there was a very heavy rain during the night of the 24th, and next day, when things dried off, no noticeable destruction of scale had resulted. But there was a whitish deposit, probably resin, on all the treated surfaces, and it would not be fair to condemn the soap as valueless for insecticide purposes on such evidence were there no other objections to its use.

July 23d, placed specimens of adult *Chilocorus similis* under the cages over trees 32 and 36. This matter is more fully explained elsewhere in the Report and needs only a mere suggestion here.

August 24th, everything was swarming with larval scale insects and it began to seem as if some work would have to be done. So, on September 1st, I sprayed all the very badly-infested trees with whale-oil soap (Good's No. 3) at the rate of one pound in two and one-half gallons of water, and the application was very successful.

September 8th, applied ground tobacco about the roots of all trees save Nos. 32 and 36, and on October 2d examined all the peach trees for borers; none were found. No cement coating was applied this year, for there are now no other peach trees within easy range of my grounds.

Frost, hard enough to kill the leaves, came on the night of October 22d, and active breeding ceased about that time. Scale larvæ were found after November 1st, but in small numbers.

It should be said that in February there was a very heavy sleet storm, which severely injured trees throughout many sections of the State, and that the Experiment Orchard did not entirely escape.

TREE 1—*Mariana Plum.* March 30th, buds were swelling and showing green all over. Plenty of scale in centre of tree on old wood; less outwardly, and the new shoots were practically clean. The tree had been somewhat broken by the sleet storm and the broken shoots were then cut out, as were some of the interfering newer shoots. It moved slowly until leaf buds began opening April 18th, and the

blossom buds began to separate. The first flower opened April 22d and on the 25th the tree was in full bloom.

April 28th, sprayed trunk, main branches and a little foliage with *Calcothion.*

May 1st, bloom was almost gone, the trees were advancing and I made another local application of Calcothion, avoiding foliage as far as possible. May 4th, the little shoots hit by the spray were drying up. May 7th, I again applied the mixture on the trunk and inner branches. May 12th, all the young shoots and foliage hit by the material were dead. On the 7th a little fruit had set and more twigs were dead. Examined some parts of the treated area and found no live scales. The fruits dropped one by one until, July 4th, only half a dozen were left. At this time there was no breeding, but a few new scales were observed on the new wood. July 12th, the scale on the lime-washed area was dead and dry; plenty of scale on last year's wood; very little on the new growth. August 12th, all the fruit was off and the tree was growing rankly; scale situation unchanged. October 22d, was yet in full foliage and the scale was certainly less than last month, the old wood clearing up nicely; but there was plenty of live scale and some shoots were very bad. Cut off two of the lowest branches, which were near the ground and much shaded by the fence.

TREE 2—*Yellow Transparent Apple.* Trimmed back well during the winter, taking off half of the new growth. Buds were swelling March 30th, scattering scale was all over the tree and four specimens of the two-spotted lady-bird were feeding on it. April 23d, leaf buds opened, and May 7th, was in full leaf. On that day sprayed trunk and base of main branches with Calcothion, avoiding foliage so far as possible. May 12th, that which was hit was dead and drying up. June 9th, sprayed with arsenate of lead to kill web-worms, and up to the 17th it killed all as fast as they developed. On that day the lime was all off. This tree has a very smooth bark and was sprayed for that reason to test sticking quality of mixture. Up to July 12th no larvæ were observed on the tree, but there was a little fresh scale on the new wood, which may have come from outside. The trunk and branches at that date were almost free from scale, and most of what remained was dead.

August 12th, growth had stopped, the leaves were much affected by leaf-hoppers and there was more scale on the new wood. August 15th, took off two colonies of web-worms and sprayed with arsenate

of lead. Leaves began to die and some to drop August 21st, and on September 1st crawling larvæ were rather abundant. Sprayed with Good's whale-oil soap, No. 3, one pound in two and one-half gallons of water, and made the application very thorough. The leaves were perceptibly scalded September 8th, but the larvæ and recent sets were wiped out.

October 22d, about 60 per cent. of the foliage was off and the balance was dry and lifeless. Scale was all over the tree, but nowhere bad; less on the trunk and base of branches than elsewhere and more on the ends of the new growth than anywhere else.

Two points are noticeable in this connection—the good effect of the arsenate of lead in keeping down the web-worm colonies, and the fact that little attempt was made by scale larvæ to set on the trunk and base of branches, even late in the season, when all apparent trace of the sulphur wash was gone.

TREE 3—*Black Tartarian Cherry*. Buds had started March 20th, but were not free until April 16th; on the 18th leaf buds were opening, the white of the blossoms began to show, and on the 21st half the flowers were open. The scant bloom was full on the 22d and the foliage was almost complete. May 1st, all the bloom was gone and the tree was in full foliage. A very scant set of fruit was made; the plum curculio attacked some of these and the robins got everything else as soon as it was anywhere near ripe.

The tree grew well throughout the season, and on October 22d, while I could find an occasional scale, there had been no recent breeding.

TREE 4—*Abundance Plum*. March 30th, buds were well advanced and blossom clusters were separating. Little trimming had been done; there was some scale everywhere to the tips of the shoots, and locally it was pretty bad. April 16th, blossom clusters were free and many were showing white; on the 18th they began to open and on the 22d all were out full. Petals began to drop on the 23d and on the 28th only a few scattered flowers were left.

May 7th, sprayed trunk and base of branching with Calcothion. There seemed to be a fair set of fruit on the 17th, but it had developed irregularly. June 1st, only a small crop remained; much of it attacked by curculio, and on the 17th scale breeding was active. The Calcothion was yet visible and there was no breeding where this had been applied. June 24th, sprayed thoroughly with the "agricultural soap," referred to in the general notes. July 4th, found

scale larvæ active, but little was on the new wood and none on the fruit. July 5th, sprayed with black soluble insecticide soap, one pound in a little over seven gallons of water.

July 12th, a dozen ripe fruits of fair size were taken off, most of them wormy, and a few cripples remained on the tree. No scale was on the fruit, but larvæ were swarming on some branches, fixing mainly on last year's wood and on the leaves. On the 15th, sprayed the worst infested shoots with the black soap, one pound in two gallons of water. Absolutely no benefit was noted, and on August 12th some of the branches were horribly scaly. Larvæ were active and were extending down the trunk.

October 22d, foliage was yet complete, but bronzed; the tree was generally scaly and in some places horribly incrusted; so much so that the shoots have become lifeless and break under the least strain.

TREE 5—*Bartlett Pear.* March 30th, trimmed off about half the new growth. Not much scale, but the sinuate borer had killed a large area on the trunk. April 18th, leaf buds were ready to open, and on May 7th it was in full foliage and growing nicely.

June 17th, there was a little pear slug; one nest of web-worms was removed and scale breeding had begun. On July 4th the larvæ extended clear to the tip of the new shoots and even on to the leaves. On the 5th, sprayed with black insecticide soap, one pound in a little over seven gallons of water. On the 12th there was not much change; there were no active larvæ, no recent sets and the tree had stopped growth. August 21st, there was a new brood of larvæ and many white sets were found. Some of the leaves were already dropping, and on September 1st I drenched with Good's soap at the rate of one pound in two and one-half gallons of water. September 8th, no bad effects were noticeable on the tree; the larvæ had been wiped out and so had some of the more recent sets; but the breeders were unhurt.

October 22d, foliage was partly off and most of it dropped at a touch. It was now a very scaly tree and some shoots were incrusted. No moving larvæ, but plenty of young under the mother scales. Three, and perhaps four, sinuate borers are in this tree.

TREE 6—*Pleasant Valley Pippin.* March 30th, the tree had been trimmed to a symmetrical head and buds were beginning to swell. Some scale all over the tree and less on the trunk than elsewhere. Buds started April 18th; was in practically full leaf May 1st, and several blossom clusters were developing. On the 7th, sprayed the trunk and base of branches with Calcothion. Blossom clus-

ters out full. Where foliage was hit it was killed on the 12th, and up to the 17th no fruit had set. June 17th, ten fruits had begun to develop, chiefly on one branch, the lime wash was all gone and scale breeding had begun. On the 24th I applied the "agricultural soap" most thoroughly. July 4th, there seemed to be less scale, and much of it was dead. One branch, bearing three fruits, had wilted and was cut off. On the 12th the trunk and base of main branches were free from scale, but there was a liberal set on the outside and a little on the fruit. Below the branching there was an area of dead bark, which threatened the life of the entire top. On August 12th the dead area had extended completely round the trunk, and the leaves were beginning to turn yellow, to wilt and to drop.

September 1st, took off the few remaining apples, which were then about ripe. The top was dying, scale larvæ were now swarming and I had the tree cut down. It had been very scaly ever since it was set, had never grown very much, had suffered about all the kinds of insecticides I ever used, and died at last from general lack of vitality. There was no mechanical injury where the trunk died; it was a drying up and blackening, like the body blight of pear.

TREE 7—*Champion Peach.* The tree was cut back pretty well, but left with a fair set of fruit buds, badly distributed because the shoots were too long.

March 30th, blossom buds were swollen and leaf buds tipped green; some scale all over tree. April 18th, leaf buds had started and one blossom was open; on the 22d one-fourth of them were out, and on the 23d it was practically in full bloom. On the 28th sprayed trunk and base of larger branches with Calcothion, and on May 1st duplicated the application, extending it a little further among the branches. Bloom was all gone and a fair set of fruit indicated May 7th, and at this time the small shoots making from the inside branches were pretty well gone as the result of the spraying. Practically all these were killed off, and on June 1st there had been no new start from the sprayed area. The wash held well and no breeding was observed until July 12th. At that time everything on the lime-treated area was dead and very little live scale was noted anywhere. The trunk was still lime-coated and was very rough and scaly. A month later there was enough live scale scattered about to make a very decent infestation, but there were few active larvæ. The fruit had taken a start and made great gains in size and color.

August 14th, sprayed with arsenate of lead, one pound to ten gallons of water, to discourage fruit feeders. On the 22d the tree was raided by a gang of street loafers, and to avoid further trouble all the fruits were removed, though not quite ripe. The crop was fair and the fruits were of extra size and very good quality.

October 22d, was yet full in foliage, not very scaly, not much on the new growth and no crawling larvæ. The tree was making its fruit buds badly, partly due to bad pruning and partly due to killing off the inside shoots with Calcothion. No new shoots started on the sprayed area, and it seems indicated that on peach trees the lime, salt and sulphur wash must not be used too late in the season. The shoots were killed down to their base, and, apparently, a start from dormant buds was prevented.

TREE 8—*Grimes' Golden Pippin.* The tree was cut back during the winter and more than half of last year's growth was taken off. April 18th, it was starting well, some leaflets were unfolding, and by May 1st it was practically full leaf; there was no bloom. May 7th, sprayed with Calcothion the trunk and base of larger branches, avoiding foliage so far as possible. On the 12th such foliage as was hit was drying up. June 9th, sprayed with arsenate of lead, and on the 17th I noted that several nests had started and been nipped in the bud by this application. Scale breeding had begun and some white scales were found. On the 24th sprayed with the agricultural soap. July 4th, there was considerable scale locally, mostly on last year's wood. The trunk still showed the lime coating and little live scale. Several other nests of web-worms had started, but only one had become established, and in it I found a few live caterpillars. On the 12th no living scales were on the trunk or base of the larger branches, but there were plenty on last year's wood. Leaf hoppers were also plentiful. A month later growth had stopped, leaf hoppers were present in large numbers and a full brood of scale larvæ was moving. August 15th, sprayed with arsenate of lead, to kill off the second brood of web-worms, which was beginning to show. On the 21st the tree was fairly swarming with larvæ and recent sets.

October 22d, the tree was yet in full foliage, but was a real bad case of scale infestation. There was not much on the older wood, but outwardly the new growth was fairly incrusted—even the leaves were set full and many of the fruit spurs are probably killed. There were plenty of active larvæ and dozens of *Pentilia misella.*

This is a well-shaped, apparently vigorous tree, and its complete coating of scale, from a start after the middle of July, is an interesting example of the possibilities of the pernicious scale on a susceptible tree.

TREE 9—*Champion Peach.* The tree had been cut out pretty well during the winter, leaving the fruit buds located well out on the shoots. They began plumping out March 31st, with plenty of scale, mostly dead, on the old wood and little on the new growth. April 18th, leaf buds were developing and some blossoms were ready to open. On the 21st several had opened, and on the 23d the tree was in full bloom. May 7th, was leafing out fairly and not yet all out of bloom. Shoots were making all over the lanky main branches, and this promised to be a good subject for the dehorning process. June 17th, the fruit was developing normally, the scale had begun to breed and the inside shoots were growing well. July 4th, there was an abundance of larvæ, but they did not seem to get out much—setting on leaves and inside branches rather than on the shoots. August 12th, the fruit began to color up, there was not much scale anywhere and very little on the rough, scaly trunk. On the 15th sprayed with arsenate of lead, one pound in ten gallons of water. On the 22d a raid was made by street loafers, and to avoid further trouble the fruit was taken off, unripe. The crop would have been fair and of extra quality. This was proved by the few ripe examples that were actually obtained.

October 22d, the tree was yet in full, healthy foliage, scale was all over it and, in some places, pretty thick. There were no crawling larvæ, but many recent scales. The tree has made a very good inside growth and has developed some fruit buds there. Standing, as it does, in a fence corner, the tendency is to make a lanky growth, and this tendency was not sufficiently checked in the beginning of the growth by proper pruning.

TREE 10—*Late Rose Peach.* Was so badly broken by the February sleet storm that it was deemed best to take it out.

In March a clean Greensboro peach tree, trimmed to a straight, four-foot stick, was placed near the place where No. 10 was taken out, and will bear the same number. It grew well during the season and was a little scaly in late October.

TREE 11—*Late Rose Peach.* Was so badly broken in the February sleet storm that it was taken out and no other set in its place.

TREE 12—*Fox Seedling Peach.* Was somewhat broken by the sleet storm and pretty well cut back. March 31st, the buds were plumping out, there was plenty of scattered scale, but much of it was dead. April 21st, a few flowers were open; on the 23d it was in full bloom, and on the 28th it was dropping petals fast. All the bloom was off May 7th; it was leafing out full and new shoots were making along the bare, inside branches. On the 23d whitewashed the trunk and larger branches at base. June 17th, scale breeding had begun and the lime coating was yet quite complete. July 4th, there was yet some lime on the trunk and no scale had bred on the treated area. The new growth was throwing off scales, but there was plenty on last year's wood and on the leaves. On the 5th sprayed with the black soluble insecticide soap, at the rate of one pound in a little more than seven gallons of water. No marked benefit resulting, I sprayed again on the 15th, aiming at the older, most infested wood, to the neglect of the outer shoots. The mixture was one pound in two gallons of water. No benefit resulted, and on August 12th the base of the new shoots was very scaly and some of the older wood was coated. On the 24th many of the unripe fruits were knocked off by loafers, but nearly half a basket was harvested in September, only fair as to size and quality. As the situation of the tree was such as to invite raids from the hoodlum element, it was cut out on October 22d.

TREE 13—*Fox Seedling Peach.* Was so badly broken in the February sleet storm that it was taken out.

TREE 14—*Seckle Pear.* The shoots were a little shortened in during the winter, and on April 18th leaf buds were starting well. May 1st, it was in full foliage, and on the 23d applied a coat of whitewash to the trunk. This was off June 1st, and on June 11th sprayed with arsenate of lead, to keep off web-worms. Several had started and had been killed up to the end of June, but on July 4th I found and removed a small brood of well-advanced larvæ. At that date the scale was breeding and young were setting toward the tips of the new growth, which had stopped. August 12th, scale was all over the tree and about ready to multiply.

October 22d, most of the foliage was off and last year's growth was coated with scales; even the leaves were scaly. This tree is almost buried in very tall blackberry bushes, is overshadowed by tree No. 37 and may have to be abandoned.

TREE 15—*Japan Golden Russet Pear.* Buds were well advanced March 31st, and on April 16th the blossom clusters were separating and already well advanced. On the 23d one blossom was open and on April 30th all were out. May 1st, petals began to drop, and on the 7th most of them were off. May 18th, had made a full set of fruit, and on the 23d applied a coat of whitewash to the trunk and larger branches. The mixture stuck well to July 4th, and there was no scale where it had been. August 12th, growth had stopped, there was no scale on the fruit and very little anywhere else. On the 24th fruit was beginning to crack, but there was much less codling moth than in any previous year.

TREE 16—*Japan Golden Russet Pear.* Has practically the same history as No. 15 and has received the same treatment. It set a little more full and matured more fruits, but they were smaller and more of them cracked. There is, perhaps, a little more scale, but the condition under which it occurs is the same.

TREE 17—*Keiffer Pear.* March 31st, the buds were breaking into blossom clusters, which became separated April 16th. More than half the new growth had been cut off during the winter, and there was a scattering of scale all over the tree.

Blossoms began to open April 22d, and were practically all out on the 25th. May 7th, the tree was in full foliage and all the bloom was gone. May 18th, a moderate set was indicated and one fruit infested by pear midge was found. There was a heavy drop by the 23d, including most of the midge-infested fruits; but I removed at least twenty others and destroyed them. Applied a coat of whitewash to trunk and base of branches. June 1st, most of this had washed away, and on the 17th it was nearly all gone. No scale breeding was noted and the fruit was developing well. June 24th, sprayed with the agricultural soap. July 4th, there was some scale, in all stages, all over the tree, but more on the fruit than elsewhere. No advantage from the spraying. August 10th, applied the black insecticide soap to the south side. The tank emptied before the north side was completed, but there were some thick dregs which I put on, to see if harm would be done. On the 12th the soap had had absolutely no effect and the fruits were getting very scaly. Foliage began to drop on the 21st, and only a little fruit remained. September 1st, the entire tree was very scaly, leaves and fruit were both dropping, and I sprayed with Good's whale-oil soap, No. 3, one pound in two and one-half gallons

of water. On the 8th the leaves seemed considerably scalded, but practically all the crawling brood was wiped out.

September 10th, what remained of the fruit was ripening. When picked it was of excellent flavor, undersized for Keiffer, but with more Bartlett than Keiffer texture and flavor. October 22d, foliage was about all off, but the wood seemed healthy and the fruit spurs were plump. Some scale all over the tree, but no coating. There are indications of several sinuate borers and depressions for at least three pupal chambers.

TREE 18—*Keiffer Pear*. The tree had been sharply cut back during the winter, and March 31st the buds were well advanced and breaking out into clusters. Scale all over tree, but not much on trunk, which, however, harbors several sinuate borers and has an area of body blight.

Blossoms began to open April 23d; 75 per cent. were out on the 25th, the balance came out a day or two later, and on May 1st the petals began to drop. May 7th, the tree was in full foliage and the flowers were all gone. May 18th, the set was moderate only and fully half the sets were midge blighted. On the 23d, after I had removed all infested pears, only a scanty set remained. On this day applied a coat of lime on trunk and lower branches, which was very imperfect on June 1st. On the 17th the lime was about all gone and there had not yet been any breeding. July 4th, scales in all stages were scattered over the tree and the fruit had comparatively more than any other part. On the 12th conditions were no better and some fruit was very scaly. August 10th, applied black insecticide soap so as to drench, but on the 12th there was no apparent benefit; there were just as many scales as there had been before the application. On the 21st both fruit and foliage were dropping, and on September 1st the fruit was undersized and scaly. Leaves and fruit continued to drop, and I sprayed with Good's whale-oil soap, one pound in two and one-half gallons of water. On the 8th practically the entire crawling brood had been wiped out, without harm to the foliage. Fruit began to ripen on the 10th and, as in the preceding, was of excellent quality.

October 22d, the tree was scaly throughout and in some places very much so; but no breeding at that time. About half the foliage was off and sinuate borers were indicated at three points.

TREE 19—*Keiffer Pear*. Was sharply cut back during the winter; had scale all over, except on the trunk, the latter slit all around over areas of body blight. Sinuate borers evident. Buds were well

advanced March 31st, and blossoms clusters became freed April 16th. On the 23d a few flowers opened, and by May 1st the petals began to drop, the tree being then in full leaf. May 18th, there was a light set, badly infested by the midge, from which fruits were picked off, from time to time, until, on the 23d, there was only a scant remnant. On that day whitewashed the trunk and base of branches. June 17th, the wash was about all gone and scale breeding had begun. On the 24th sprayed with the agricultural soap; but on July 4th active scale was all over the tree, extending to the tips of the new growth and covering the fruit. On the 5th sprayed with black insecticide soap, one pound in six gallons of water. On the 12th conditions were no better, and on the 28th drenched with the black soap, one pound in two and one-half gallons of water. The application was repeated, at the same strength, August 10th, and on the 12th there were more young and white sets than ever before. September 1st, this was a very badly infested tree, and I sprayed with Good's soap, one pound in two and one-half gallons of water. On the 8th quite a lot of leaves were scalding, but practically the entire crawling brood was wiped out. Only a few fruits ripened properly, and on October 22d all the foliage was off, the tree was only moderately scaly and several sinuate borers are noticeable in trunk and branches.

TREE 20—*Meech Quince.* Cut back moderately, leaving a lot of little branches, which seemed free from scale. Buds were pointing out March 31st, but did not really start to unfold until April 23d. Was in full foliage May 12th and a few blossoms were opening. Was practically out of bloom May 23d, and I whitewashed the trunk to the branching. June 1st, there were three well-set fruits and most of the lime was off the trunk. June 11th, sprayed with arsenate of lead, which, by the 17th, had killed off several nests of web-worms. A few more blossoms were out, but no more fruit set. Two undersized fruits matured, and on October 22d the tree was yet in full foliage, with the merest trace of scale.

TREE 21—*Keiffer Pear.* Was cut back pretty well during the winter, but plenty of wood was left inside. The main branches all have sinuate borers, there is a little scale all over the tree and at a few points it is massed. March 31st, the bud clusters were well developed, and on April 18th the buds had separated out. Flowers began to open on the 24th; on the 26th it was in full bloom, and on May 1st was also in full foliage. A week later all the bloom was off; only a light set of fruit remained on the 18th, and so much

of that was infested by pear midge that on the 23d only a very little remained. Whitewashed the trunk and base of branches; but by June 17th practically all trace of the lime was gone. July 4th growth had stopped, scale was active all over the tree, to the tips of new shoots, and over the fruit. Web-worms had been killed off, as they started, by arsenate of lead, applied on the 11th. July 28th sprayed thoroughly with black insecticide soap, one pound in two gallons of water, and on August 10th repeated the application so as to drench. On the 12th no benefit could be noted from the application, white sets and crawling larvæ being abundant. September 1st, the entire tree, including fruit, was very scaly, and I sprayed with Good's soap, one pound in two and one-half gallons of water. On the 8th some leaves had been scalded and a few had dropped, but the young scales were completely wiped out and not a crawling larva was seen. What little fruit remained ripened about the middle of the month and was very good, though undersized. October 22d, was yet in full foliage, scaly throughout, but not nearly so bad as in September. Less appearance of sinuate borer than elsewehere in this series, while the fruit spurs are better.

TREE 22—*Japanese Chestnut.* Leaf buds began opening May 1st: blossom sprays were developing June 1st, and were in full bloom July 4th. No fruit set, but the tree grew well throughout the season and was not the subject of any experiment. October 22d, there were a few scattering scales and the foliage was beginning to drop.

TREE 23—*Greensborough Peach.* This tree replaces a Pride of Franklin, which was so badly broken by the February sleet storm that it had to be taken out. It was clean and cut to a straight, three-foot stick. Had made a good start May 1st, grew well during the season and remained free from scale until October 2d, when some half-grown examples were noted on the trunk, where a label wire had almost girdled it. Was yet in full foliage October 22d, and the scales had not increased in number.

TREE 24—*Greensborough Peach.* Has practically the same history as No. 23, and like it, replaces a Pride of Franklin tree. It had one blossom—a large, showy flower. October 22d, it had made a fine growth, foliage was yet complete and there were a few scales on the older wood.

TREE 25—*Apricot.* Cut off all the shoots that would not tie well to the trellis and shortened in the others. Flower buds showed red March 31st and began to open April 15th. Was in full bloom on the

and practically out of bloom on the 23d. No fruit set, but the grew well throughout the season, making its usual long shoots. :mained clean until October 22d, when a few scales were observed, foliage remaining almost complete.

REE 26—*Nectarine.* Was cut back pretty well during the winter; clean and making a start April 18th. The tip borer became evi- May 1st and increased, as the foliage became more abundant, l May 18th; the leaves were gnarled and twisted and a large entage of the shoots had been attacked. The trunk was white- ied on the 23d and the mixture stuck well for a month. On the le, the tree did fairly well during the season, but became somewhat ided from the heavy winds. The foliage was always a little led, but of a healthy color. October 22d, it was yet in full leaf, there was a little scattered scale on the old wood.

REE 27—*Cratægus.* A few sprawling shoots were cut out during winter, but otherwise the tree was left to do as it would. March , the buds were pointing out, and there was a very little scale on new wood.

pril 18th, leaflets began to unfold, and on May 1st it was in full ıge. Plant lice became rather plentiful June 17th and were curl- the foliage July 4th. Early in August it made a new start and scale became more obvious. October 22d, it was yet in fair foliage, tle scaly all over and full of female plant lice, that were oviposit- There were, already, eggs in large numbers.

REE 28—*Early Michigan Peach.* The tree was only shortened in tle during the winter and had a few scattered scales. Buds were ling March 31st, but no blossoms opened until April 22d. Was ull bloom on the 25th and out of bloom, in full foliage, May 7th. the 18th some tips were curled by plant lice, among which *Adalia :ncta,* the common two-spotted lady-bird, was busily feeding. On 23d applied whitewash to the trunk and base of branches, and this k well until after the middle of July. No breeding scales were June 17th, but the foliage looked ragged and as if infested by -hole fungus. The tree grew well, the fruit developed normally little scale breeding was noted to August 12th. The fruit began olor, and on the 22d it was taken off, unripe, after a raid by street ers. The crop was sufficient in quantity, and, judging from a few ned examples, would have been satisfactory as to quality.

ctober 22d, was yet in full foliage and in general good shape.

Had more scale than at any previous period of its history, but that was not much.

TREE 29—*Gravenstein Apple*. The new growth was considerably shortened in during the winter and a little was cut out. There was considerable scale all over the tree, and in some places a good deal of it.

No start was made until April 15th, and not until May 1st was it leafing out generally. On that day applied Calcothion liberally, aiming primarily at the trunk and branches, but giving the small foliage a good dose in the lower part of the tree. On the 4th many of the smaller leaf tufts were dead and most of the leaves were materially injured. On the 7th applied another coat of Calcothion, which killed everything on the sprayed area and left it completely bare May 18th. A little active scale was observed July 4th, but none on the sprayed area, which yet showed traces of the application. On the 12th there was quite a little on some of the spurs, but a month later it had not increased, and at that time the first nests of the second brood of web-worms were destroyed. August 15th, sprayed with arsenate of lead and no further trouble was had with caterpillars.

October 22d, the tree was yet in full foliage. All the old wood where Calcothion had been applied, was entirely free from scale and only a little of it was found on the outer shoots. The most interesting outcome of this examination was a twig with the characteristic egg punctures of the periodical cicada.

TREE 30—*Grimes' Golden Pippin*. This tree had made a great deal of inside wood and this was trimmed out very materially during the winter. The bark was rough and had a tendency to scale off, but was sound below this outer coating. There was a little scattered scale.

April 23d, buds were pointing out all over the tree and a few were opening, but not until May was it in full foliage. On the 18th destroyed a colony of woolly lice on a bruised branch, and on the 22d applied whitewash on trunk and lower branches. June 11th, applied arsenate of lead, and on the 17th it was found that this had destroyed several colonies on the first two leaves attacked. Very little lime remained at this time. July 12th, there was very little scale anywhere, but plant lice were becoming quite plentiful on some shoots. A month later matters had not changed much, except that plant-louse injury to the tips of shoots was noticeable and that leaf hoppers were somewhat abundant. On the 15th applied arsenate of lead, one pound

ten gallons, and this seems to have caused a drying of the leaves, ne of which were dropping on the 21st.

September 1st, scale had increased materially and there was a brood crawling larvæ, so I sprayed with whale-oil soap, one pound in o and one-half gallons of water. This cleared out the crawling od and killed a little more foliage, as well as a lot of the plant lice it were on the tree; but on the 8th new, active larvæ again made eir appearance.

October 22d, foliage was beginning to drop naturally. Some anches were quite scaly; there were a number of colonies of the olly louse, and on every shoot eggs of the apple louse were in undance and being added to. This tree seems an excellent subject r every kind of insect attack and offers no resistance at all to their ıltiplication.

TREE 31—*German Prune.* This tree had grown long, ragged oots, which were cut back more than one-half during the winter. iere was quite a bit of scale and most of it was alive. Leaf buds gan opening April 23d, and by May 7th foliage was complete. It ew its usual lanky shoots during the summer; was not made the bject of any experiment, and was in tolerably good condition until tober. On the 22d of that month foliage was more than half off, ere was more scale than ever before on the older wood and there re plenty of active larvæ to increase the infestation.

TREE 32—*Lawrence Pear.* Was shortened in, a little only; found be generally covered with scale, and made its start April 23d. Was full foliage May 7th, and had a little bloom, on which no fruit . Scale breeding began June 18th, and larvæ had already worked t to the extreme tips. On the 24th sprayed thoroughly with the ricultural soap, and on July 4th found that sets extended to the ry end of the new shoots. July 5th, sprayed with black insecticide ap, one pound in six gallons of water, but on the 12th there was a arm of larvæ and recent sets extending even to the leaves. Growth d stopped at this time, and as the tree was not too large and had good coating of scale, it was selected as one of the two to be covered r breeding *Chilocorus similis,* the Chinese lady-bird, that feeds on e pernicious scale. The screen cage, 4 x 4 x 7 feet, was put in place ly 22d, and after that the tree was left to itself. The observations the Coccinellids are elsewhere recorded.

October 22d, foliage was beginning to drop, the tree seemed to be

in very fair condition, all things considered, and it was certainly, to all appearances, just as scaly as ever—but not more so.

TREE 33—*Dwarf Duchesse.* Was cut only enough to keep it symmetrical, and on March 31st was moving well forward in development. Leaf buds were pointing out, blossom clusters were swollen and there was a little scale all over the tree. April 22d, the flowers began to open; on the 25th was in full bloom, and on the 28th petals began to drop. May 1st, was in full foliage and almost out of bloom. Less than a dozen fruits set, and all of these withered and dropped by June 1st. All growth had stopped June 18th, but a new growth started July 4th, when there was a very little scale and some blister mite. August 12th, the scale had taken a new start and began to cover things, even unto the leaves; so, on September 1st, I included this in the list of trees sprayed with whale-oil soap, one pound in two and one-half gallons of water. No harm was done to the tree, while the moving and recently-set brood was wiped out; but on the 8th another swarm of larvæ began to appear.

October 22d, was yet in practically full foliage, scaly all over—at a few points even coated—but, on the whole, not a seriously-infested tree.

TREE 34—*Lawrence Pear.* Is a scrub; scaly, scurfy and everything else that is bad—really not worth keeping as a tree.

Made a start April 23d, and was in full foliage May 1st. Growth stopped June 18th, and the scale began breeding as a compensation. The insects did not multiply greatly, for some reason, and up to September 1st there was no bad infestation. On that date, as there were some moving larvæ, I sprayed with whale-oil soap, one pound in two and one-half gallons of water. This killed off the young, and on the 8th nothing was seen of larvæ or recent sets.

October 22d, the foliage was yet complete, the old wood was moderately scaly, the new wood practically clean. A sinuate borer is in one of the smaller branches.

TREE 35—*Japanese Walnut.* No pruning was done, and the tree had a few, scattered scales when the season opened. The terminal leaf buds began opening April 23d. May 7th, foliage was well advanced, with blossoms about ready to open. May 12th, was in bloom, and on the 18th the flowers were all gone. Several clusters set, but only two nuts came to maturity. May 23d, whitewashed the trunk, and on June 18th the lime was practically all off. The scales noted

in spring seemed to disappear by midsummer and no more were noted until the late examination in October. On the 22d of that month more than half the foliage was off, the tree seemed in excellent condition and there was a scattering of half-grown scales on the trunk. All were of about the same size, and, apparently, there had been no breeding.

TREE 36—*Apple* (variety unknown). Was trimmed in a little, and at the opening of the season was scaly throughout, but not dangerously so. Not until May 7th did any leaf buds begin to open, and not until after June 1st was it in full foliage. Scale breeding was in full swing June 18th, and on the 24th sprayed with agricultural soap. Not much result was observed from this, and on July 4th the tree was again swarming with larvæ. On the 5th sprayed with black insecticide soap, one pound in six gallons of water, with the usual lack of good results. July 22d, the tree was very scaly and was covered with a wire cage, 4 x 5 x 8 feet, into which were introduced a dozen *Chilocorus similis,* received from the United States Department of Agriculture. No other experiments were made with this tree, and it was left to take care of itself. October 2d, there was a large number of colonies of woolly plant lice—more than the tree had ever had before. On the 22d it was in full foliage, scaly as ever and with more woolly lice than all the other trees combined. The surface of the ground was full of long grass and offered excellent opportunity for hiding places for the *Chilocorus.*

TREE 37—*Spaulding Plum.* The new shoots were cut back one-half during the winter, but no cutting out was done. Some scales were on all parts of the tree, but not enough to hurt anywhere and very little on the new wood. The tree started unevenly, as usual; some buds showing white, in lower part of tree, April 18th, while the upper shoots were yet entirely bare. April 25th, was in full bloom, and on the 28th the flowers began to drop. May 1st, it was leafing out to the tips and all the bloom was gone. May 7th, applied Calcothion to the trunk and lower branches, avoiding foliage so far as possible. No injury was done, and on the 23d there was a small set of fruit on the lower branches. No scale breeding was noted until after July 4th, at which date not a sound fruit was left. August 12th, all the fruit was gone—rot, curculio, drop and otherwise—and not a single example ripened normally. Very little scale anywhere on the tree and none where the lime wash had come.

October 22d, the foliage began to thin out at the tips of the shoots, there was a mere scattering of scales at the joints and the tree had made an excellent growth.

TREE 38—*Baldwin Apple.* Was a little cut back during the winter and a few interferences were removed. The tree was very scaly and, outwardly, most of it was alive. It started, irregularly, April 18th, and was hardly in full foliage May 1st, when I applied Calcothion on the trunk, branches and in the interior of the tree. Foliage was hit freely, but I did not make the spraying general. May 4th, most of the leaves hit by the spray looked burned and lifeless. On the 7th again applied Calcothion, avoiding foliage as much as possible. May 18th, all the leaves hit by the spray were gone, and on the trunk and branches the wash still formed a good coating a month later, when the scale began to breed. July 13th, the tree was doing well, no live scale was on trunk and in lower part of tree, but plenty of it on last year's growth. No larvæ or recent sets were noted. A month later growth had stopped and leaf-hopper injury became apparent. There was only a little scale and that was well scattered. As web-worms were becoming obvious, sprayed, August 15th, with arsenate of lead, one pound in ten gallons of water. This application was duplicated on the 19th, because colonies were seen starting well up in the tree, and thereafter no more were noted.

October 22d, the tree was in good condition and yet in full foliage. There was practically no scale on the trunk and larger branches, but quite a bit on some of the outer shoots.

TREE 39—*Fallowater Apple.* Only enough cutting was done to give the tree a symmetrical top. Plenty of scale—much of it dead—but some branches very much encrusted. April 18th, the tree made an irregular start, and May 1st it was in tolerably full foliage, with several blossom clusters, on which no fruits set. May 7th, Calcothion was applied to the trunk only, and by June 1st very little of it remained. June 11th, sprayed with arsenate of lead, which checked web-worms as they came on. Scale breeding began on the 18th, and on July 4th the tree was in very poor condition; some shoots were dying, all others had stopped growth and scale was everywhere. July 5th, sprayed with black insecticide soap, one pound in six gallons of water. There seemed to be less active scale on the 13th, and on the 15th sprayed again, using one pound of the soap in two gallons of water. On the 28th another application, of the same strength

was made, and fully a gallon of the mixture was applied. August 12th, some twigs were dying and there was a new brood of larvæ moving. On the 19th sprayed with arsenate of lead, to kill web-worms of the second brood. On the 21st the tree was swarming with larvæ and recent sets, but there was comparatively little on the new growth.

October 22d, the foliage was yet quite complete, except on some very scaly shoots. The upper part of the tree is very scaly and some branches are simply encrusted. *Pentilia* is very abundant on this tree.

I have always expected this tree to die. It was a poor stick from the beginning, and since February, 1899, it has had no general winter treatment. It has become very badly infested year after year and has always received late summer applications enough to carry it safely through until the season following. I have not cut it out simply because I am curious to see how much a tree like this will really stand.

TREE 40—*Lincoln Coreless Pear.* The long shoots were cut back a little, but no other pruning was done, and when the season opened there was a little scale all over the tree. Leaf buds began to open April 23d, and May 1st it was in full foliage. June 18th, scale breeding began with a rush; a colony of web-worms was destroyed, and on July 4th scales were on the leaves, as well as on the new wood. No spraying was done on this tree and nests of web-worms were crushed as they were noticed until August 19th. Then they became so numerous that I applied arsenate of lead, one pound to ten gallons, and had no further trouble.

October 22d, the foliage began to drop and the tree was just about as scaly as usual at the same season. On the old shoots the mature scales were beginning to drop off.

TREE 41—*Greensborough Peach.* The Elberta peach that occupied this place was so badly broken by the February sleet storm that it was taken out and replaced, in March, by one of the above variety, cut to a straight, four-foot stick. It started April 23d and grew well throughout the season. Scales were first seen August 12th, and from these the trunk became pretty well covered by October 22d. The foliage was yet complete, but stripped readily.

TREE 42—*Elberta Peach.* The tree was cut back during the winter so as to leave buds well distributed for a good crop. At the beginning of the season the tree was pretty evenly scaly, but no winter applica-

tion had been made. The first blossoms began to open April 20th; on the 23d it was in full bloom, and by May 7th it was in full foliage, with the flowers all gone. May 12th, sprayed with whitewash until the trunk and old branches were white. Used Nixon pump and Bordeaux nozzle. Avoided the outside foliage, but made no attempt to save the inner leaves. A rain during the night made the coating imperfect next day, but on the whole it stuck well, being yet obvious a month later and not all gone two months later. The inside shoots hit by the wash dried up and dropped, and not until the middle of June did any new shoots start to fill the gap. Scale breeding began June 18th and continued practically unchecked throughout the season, getting on the leaves and branches everywhere, but not much on the trunk, which was rough and hard. A little got on the fruit, but not enough to injure it. July 5th, sprayed with black insecticide soap, one pound in about six gallons of water, but without any apparent benefit.

October 22d, foliage was beginning to drop. There had not been much growth during the season and the fruit buds are badly placed for next year's crop. This is due in part to the killing of the inside shoots, which were not replaced by fruit-bearing shoots later in the season. On the area that had been lime-covered there was not much scale, but, outwardly, some of the shoots and branches are pretty well incrusted.

There was a pretty good set of fruit, and when it developed there proved to be as much as the tree could reasonably carry. It began to color up in August and was fully colored by the 24th. Up to September 1st fully a basket of fine fruit had been taken off, and by the 8th nearly another basket had been secured, all very large and good.

TREE 43—*Early Richmond Cherry.* This tree was ready to start March 31st, and blossoms began to open April 22d. Was in full bloom April 25th and out of bloom May 1st. A rather small set of fruit was made, which began coloring June 1st, and was at once attacked by robins, who left not a single cherry to come to maturity. Not very much growth was made during the season, and on October 22d all the foliage was yet present, with practically no scale anywhere on either trunk or branches.

TREE 44—*Elberta Peach.* In pruning, cut out very little fruit-bearing wood and left buds for a heavy crop. There was plenty of scale on the tree and much of it was alive. A start was made April 16th,

the first flowers opened on the 20th, was in full bloom on the 23d, dropping petals on the 28th and all out of bloom, but in full leaf May 7th. On that day applied Calcothion to the trunk and base of branches. June 1st, practically all the wash was off; the young foliage where hit was killed, but the older leaves seemed to remain unharmed. Scale breeding began June 18th, but the first brood seemed light and there was not much set up to August 12th, when the fruit began to get a trace of color. On the 24th the peaches were fully colored, of very good size, and there were quite as many as the tree should have. Up to September 1st fully a basket of extra fine fruit was taken off, and by the 8th almost as much more was obtained.

October 22d, was yet in good foliage, hardly more scaly than at the beginning of the season, and with a light set of fruit-bearing wood for 1903.

Tree 45—*Black Tartarian Cherry.* Was removed to the place previously occupied by a peach—No. 48. No other tree was set where this was taken out.

Tree 46—*Mountain Rose Peach.* Several branches were broken in the February sleet storm and these were removed. At the same time, trimmed so as to leave wood for a good set of fruit. There was plenty of scale everywhere, and in that respect it was the worst-looking tree on the place. It started April 18th; the first flowers opened on the 21st; was in full bloom on the 25th; dropping its petals May 1st; out of bloom and in full foliage May 7th. On the 12th sprayed with whitewash until the trunk and old branches were white; avoided the outside foliage, but made no attempt to save inner leaves. A heavy rain during the night made the lime coating imperfect at once, but some of it stuck until the middle of July. The leaves and shoots were killed where hit by the lime, but the older foliage was not harmed. Scale breeding began June 18th, at which date, also, new shoots began making on the sprayed area. The fruit moved slowly until the middle of July, up to which time the scale, also, had not made much progress. Fruit began to color August 12th, and the first fully-ripe examples were picked on the 22d. Thereafter, until September 1st, some specimens were picked every day and a very decent crop of fine fruit was secured. The tree improved immensely in appearance after midsummer, and on October 22d was yet in full foliage and excellent general condition. The inside growth had developed well, a good set of fruit buds had been made and, altogether, the tree was in much better shape than at the beginning of the sea-

son. There was scale all over the tree, but not much in any one place, while the trunk was so rough and scarred that there was little chance for the insect to maintain itself there.

TREE 47—*Greensborough Peach.* This is a clean, five-foot stick set in March to replace a Triumph, taken out because of its tendency to rot. It started April 23d, grew well during the season and was yet in full foliage October 22d. No scales were found until August 12th, but on October 22d there was a scattering everywhere.

TREE 48—*Black Tartarian Cherry.* This was tree No. 45 until in the fall of 1901, it was moved to replace No. 48, taken out because of its tendency to rot. No trimming was done, and no appearance of harm from moving was obvious until after the tree had blossomed. Then, after the fruits set, they wilted and dropped. The foliage remained complete throughout the season, but made no progress, being exactly in the same condition October 22d that it was on May 7th. No scale on the tree at any time.

It will be noted, on looking over this record, that none of the trees had a radical treatment during the winter of 1901–1902. Some of them were quite badly enough infested to call for such treatment, but it was decided to let them run their chances. On the whole, the result is interesting and instructive, since not one tree was killed or even severely injured by the neglect, while some are in at least as good condition as they were last year at the same date. The late day when the Calcothion was received made it impossible to apply it to any one tree so completely as to test its power of really clearing a tree; but, so far as it was used, it was one of the most effective preparations tried. No experiments were made with oils. This branch of the investigation may now be safely left to the fruit-growers, who will decide which of the methods advised will best meet their individual needs. In another portion of this Report the lime, salt and sulphur wash and crude oil are more specifically referred to.

THE PERIODICAL CICADA.

Cicada septendecim Linn.

The occurrence of this insect, commonly known as the seventeen-year locust, is always interesting, though its habits are now so well known that no lengthy account need be given here.

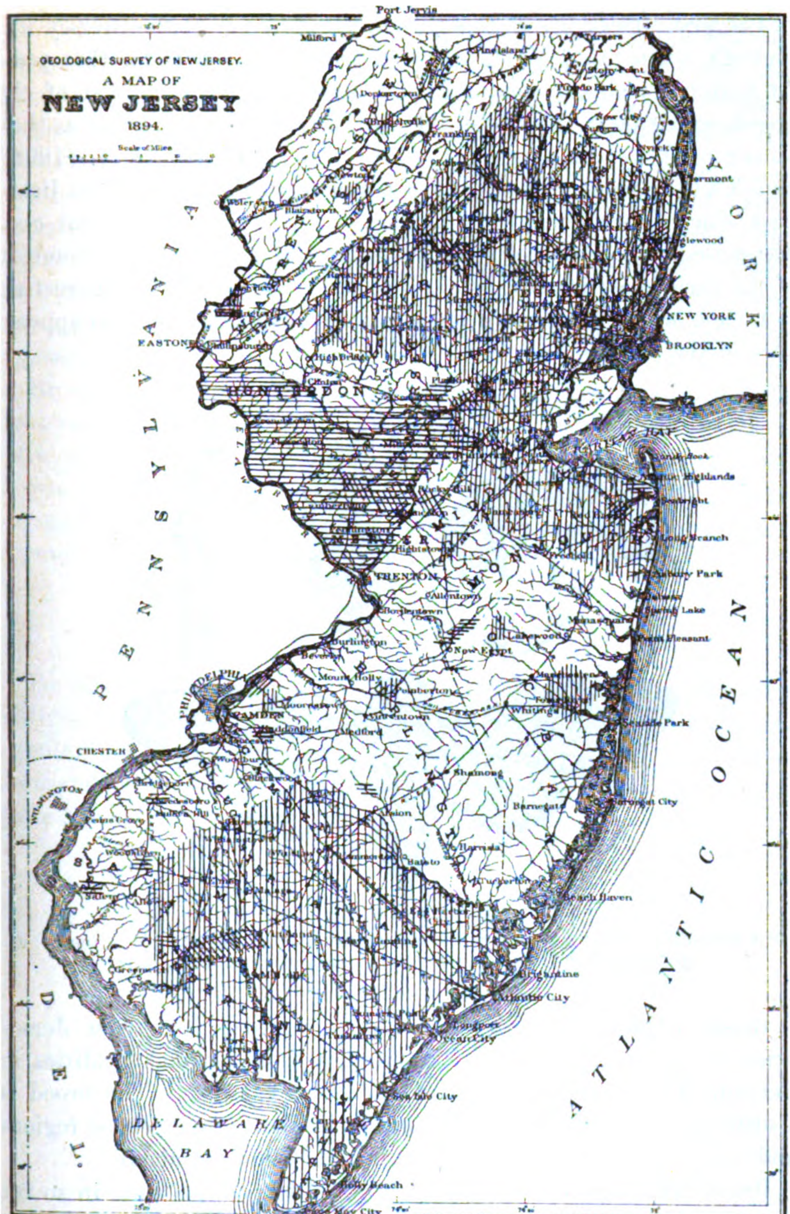

Fig. 1.

Map showing the distribution of the main broods of the Periodical Cicada. Horizontal lines, east and west, denote brood XXII (1902); vertical lines, north and south, denote brood XII. (1894); lines sloping from southeast to northwest denote brood XVII. (1896); lines sloping from northeast to southwest denote brood VIII. (1889). Where more than one set of lines cover the same area, it means that more than one brood occurs there.

The first appearance of this Cicada noted by me in New Jersey was in 1889, when brood VIII. was recorded in the report for that year. At that time, also, I compiled from published records a list of the broods occurring in this State and gave their distribution so far as then known. The broods were VIII. (1889), XII. (1894), XVII. (1898) and XXII. (1902). It will be noted that all the broods then listed have since appeared, and all of them on time, in the general area designated. In the reports for 1889, 1894 and 1898 the distribution of the various earlier broods is given, and it may not be uninteresting to review briefly these localities before recording in detail the appearance of the present year.

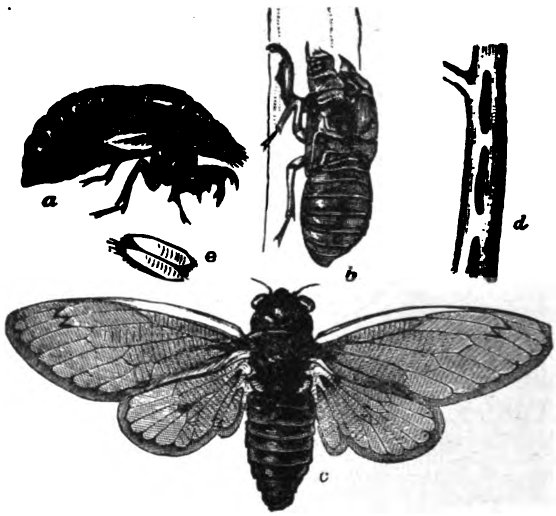

Fig. 2.

The Periodical Cicada: *a*, *b*, pupa shells from which the image has emerged; *c*, imago; *d*, punctures in which the eggs are laid; *e*, eggs enlarged. After Riley.

Brood VIII. had not been positively recorded from New Jersey prior to 1889; in that year I received it from isolated localities in Bergen, Mercer, Burlington and Gloucester counties. The brood is a small one, the area of its appearance is limited in well-settled regions and it is doubtful whether in 1906 it will be noticed at all.

Brood XII., appearing in 1894, covered the entire State in so far that there was no county that did not have at least one colony; but the stronghold was in the northeastern section, from the second range of the Watchung Mountains to the Hudson. In the southern counties

the colonies were much scattered, and so they were in the Delaware counties, only one occurring at all close to the Delaware river. The brood occurring this year (1902) is strong in the northern Delaware region and almost wanting in the northeastern area, where brood XII. was most abundant.

Brood XVII., for 1898, rested upon a single record from Essex county; but in that year my correspondents reported colonies from Bergen, Essex, Morris, Passaic, Union, Somerset, Middlesex, Mercer and Cumberland counties, none of them very extensive or very numerous and some so located that the chances are against their future reappearance.

Brood XXII. almost matches brood XII., in New Jersey, so far as area covered and numbers are concerned, but is somewhat inferior in both respects. It was well recorded in 1885, though not by me, and I was anxious to get it as fully delimited as possible. This meant correspondents from all sections of the State, and to secure these I organized a campaign, as follows:

The Organization.

To call the attention of farmers and fruit growers to the probability of the insects' appearance in certain districts, the following circular was sent to the entire bulletin list, comprising some eleven thousand farmers from all parts of the State, and this was reprinted quite generally by the newspapers, in whole or in part:

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS.

THE PERIODICAL CICADA.

A Word of Caution to Orchardists.

Brood XXII. of the Periodical Cicada or, as it is better known, the seventeen-year locust, is due to appear in New Jersey in 1902. This brood is one of the most numerous occurring in the State, and was recorded as being injurious in 1885, the date of its last appearance in Burlington, Camden, Mercer, Middlesex, Monmouth, Passaic, Morris, Warren, Sussex, Somerset and Hunterdon conntics. Its exact limits have not been defined; therefore it behooves fruit growers in all of these counties to be on their guard.

A life history of the insect is given in Bulletin No. 95, some copies of which are yet available, and in the Annual Report for 1894.

To avoid injury, growers in the sections above named are advised not to set out young orchards either in the fall of 1901 or spring of 1902 if they can avoid it. If they do set, do not prune too closely: leave as many shoots and branches as possible in which the insects may lay their eggs without harm to the tree itself. These branches may then be trimmed out early in July, when all danger is past.

Do not trim fruit or other trees or shrubs too closely, and, where not absolutely required, do no trimming at all. Do no budding or grafting either this fall or next spring, as growing buds and grafts are especially apt to be injured. The attention of nurserymen is particularly called to this matter, that they may adopt such measures as seem advisable to them. Where sparrows occur in large numbers, the danger of great injury is much reduced. This is intended as a warning merely, and not as a bulletin of information.

JOHN B. SMITH,
Entomologist.

NEW BRUNSWICK, N. J., September 4th, 1901.

In the first number of the Crop Bulletin for 1902, issued April 30th, the following notice appeared:

"The Periodical Cicada is expected to appear in several counties of the State; but the distribution in these counties is not well known. It is a matter of importance to learn the exact localities where the

insect occurs. Professor Smith asks that crop correspondents note in their reports the appearance of the insect in their respective localities. The insects will probably emerge from the ground during the last week in May, and it is important that the record be sent in as soon as the species is actually seen or heard."

The number or correspondents affected by this notice is 127, and they are scattered throughout the State, so as to reach all sorts of conditions of crop and climate.

A circular-letter, inclosing a copy of the circular already quoted, was sent to all the Insect Commissioners, under date of May 29th, 1902. The following is a copy of the letter, and it went to sixty-five persons, scattered throughout the State:

DEAR SIR—I send you inclosed herewith a copy of the circular that was sent out generally last fall. Won't you please make an effort to ascertain whether the Cicada makes its appearance in your vicinity, and if so, let me hear from you as soon as you have made certain of the fact. Yours, etc.,

JOHN B. SMITH,
State Entomologist.

In my travels through the State I kept a lookout for Cicada appearances and questioned people from all sorts of places. In this way I personally reached every county in the State, and I have traveled to the end of almost every branch of the West Jersey and Seashore, Atlantic City, and Pennsylvania railroads running south and east from Camden. I have crossed the State on the Delaware, Lackawanna and Western, Lehigh Valley, Central Railroad of New Jersey and Pennsylvania railroad. On the Erie I have run north almost to the State line, and I have visited almost every shore point between the Highlands and Cape May. While it is possible, therefore, that I have missed local occurrences, it is unlikely that any large colonies escaped being listed.

It should be added that some of the leading agricultural papers asked for records of the insects' appearance, and these papers go to every township in the State.

Finally, Mr. C. L. Marlatt kindly sent me all the New Jersey records received in the Division of Entomology of the United States Department of Agriculture.

Combining the results from all these sources, the following distribution has been established:

Distribution.

The northernmost point for which I have any record is Roxburg, Warren county, whence they were reported by Mr. J. D. Vannatta in the Crop Bulletin for June 3d; their disappearance was chronicled in the same way, on the 24th of that month. In response to a personal letter, Mr. Vannatta wrote that he had been over considerable territory in his township and found that in some localities the Cicadas were very numerous. Along the line of the Belvidere Division of the Pennsylvania railroad an area of infestation began north of Riegelsville, and this extended back from the river as far as I could see. Where the hills opened the forests of the second ridge could be seen to be as badly cut as those of the first. Just how far back this area extended I could not see; it ran north to Carpenterville, but was broken at the edges and did not reach Phillipsburg along the railroad. In fact, I ran north to Manunka Chunk, along the river and crossed the county on the Delaware, Lackawanna and Western railroad, without seeing anything more of the insect. Starting east from Phillipsburg, on the Central railroad, there is an infested area, south of the track, between Springtown and Bloomsbury, but this did not seem to be very extensive. On the Lehigh Valley railroad the insects were noted between Kennedy and Bloomsbury, a large area extending on both sides of the track for more than a mile, to the second ridge from the river. Altogether, it may be said that the southwestern corner of Warren county, south of the Central Railroad of New Jersey and along the Delaware river, is pretty well covered by this brood.

Running south along the Delaware, the Warren county area of infestation extends into Hunterdon county and for its full length. It is broken, of course, at several points, notably at towns and settled areas, but practically the ridge back of the river is all cut by Cicada. Between Riegelsville and Milford is a very large colony, which, where the hills open between Milford and Holland, could be seen to extend far back into the interior. There is a little break at Milford, but south of that cut twigs became evident once more. Then there was quite a little break to Tumble Falls, whence the infested area continued along the ridge to Raven Rock. Then there was a break to Stockton, where another colony extended to Lambertville, and south of it to the county line.

Continuing on the Lehigh Valley railroad, east from Bloomsbury into Hunterdon county, a colony was seen on the ridge before reaching West Portal. It seemed to be rather scattering, but extended south as far as I could see. Another colony was in a bit of woods between Pattenburg and Jutland, extending well toward the latter place on both sides of the track. Nothing further was seen from the railroad, but reports received continue the colonies along its line to Three Bridges. In a ride over the Flemington branch of the Belvidere Division signs of Cicada were seen at Mt. Airy, Boss' Road and Muirhead. Flemington was several times reported. Driving from Flemington to Sergeantsville, a large colony was found near the latter point. Aside from these personal observations, the insects were reported from Hunterdon county in the Crop Bulletin as follows: May 27th, Sergeantsville, by Mr. J. M. Hartpence; June 3d, Flemington, by Mr. H. E. Deats; Frenchtown, by Mr. J. W. Lequear; Kingwood, by Mr. John Bellis; June 24th, Pittstown, reported as injuring trees by Mr. L. B. Hann. July 15th, their disappearance, without injury, was announced from Rowland's Mills by Mr. J. Q. Hoagland. The earliest date of appearance is May 21st, followed closely by May 23d, 24th and 25th, which latter seems to have been the time when they first began to come out in numbers.

Other reports from this area came from Mr. John T. Cox, Readington, under date of June 4th; from Rev. F. J. Tomlinson, Pittstown, under date June 5th, and from Mr. John Bellis, Kingwood, under date June 7th. Mr. Cox reports the first examples for June 2d. Mr. Bellis gives June 5th as the date when he first heard them. Mr. Tomlinson wrote me at some length: "The vanguard began to show themselves at the surface on Tuesday, May 27th, but I did not see any come out voluntarily until Thursday night. Our little chickens did bring many out of their holes on Tuesday and Wednesday. The weather was cool and disagreeable and not to the liking of the Cicada. They seemed like impatient children, waiting favorable weather to go out. They would come to the surface and look out and then back down in their canal; but our little chickens discovered them and went locust hunting—when they saw a head in the hole they went for it, helped the owner out of it and had great fun dividing the carcass. The chickens—large and small—cats, sparrows and robins are all fond of them, but there seems to be too many for all of them. They began to come up in great numbers Friday night, May 30th."

The appearance of the woodlands over the infested area and the general tone of the reports indicate that the insects were very numerous. I was informed that some orchards in the Flemington district had suffered considerably, and in the *American Agriculturist* for July 19th there is a note from Kingwood, that "Young orchards have suffered badly from locusts. Chestnut trees show many dead branches, testifying to the destructiveness of the winged invaders." Further notes on this point appear later.

Generally speaking, the southern half of Hunterdon county may be said to have been infested and, probably, specimens extended over that entire area. North of the main line of the Central railroad I have no affirmative records, and, so far as my own observations go there is no appearance of their occurrence. It may be noted in this connection that brood VIII. occurred only in the northern part of this county, whence I have no records this year.

South of Hunterdon is Mercer county, where the next largest swarms occurred. Referring again, first, to the Crop Bulletin, Mr. E. R. Cook reported, May 27th, that "the Periodical Cicada appeared in small numbers in Ewing township." The same gentleman, under date of June 10th, writes from Trenton to the same effect, while Mr. James F. Herbert, at Trenton Jnction, reports the insects in large numbers.

June 3d, Mr. John M. Dalrymple, Hopewell, wrote: "The Cicada has made its appearance in this vicinity in very large numbers. * * * My apple orchards are full of them; also, my shade trees about my house. There are, also, immense quantities of them in the woods, less than a mile from my place. * * * I think there are now more of them than I remember in any former year."

At Princeton the insects appeared in such numbers that on June 3d Mr. J. H. Hale was able to send me a quart of specimens. Mr. Dickerson made two trips to that place later, and found the insects plentiful, but not extending to Princeton Junction.

In the course of a visit to Hightstown, June 25th, I learned that the Cicada appeared in small numbers at and very near that place, gradually becoming more plentiful in the Princeton direction. Sparrows and other enemies had cleaned up the few that appeared, and it is doubtful whether they have left sufficient for a future reappearance.

Along the main line of the Pennsylvania railroad a large area of cut twigs was observable near Lawrence Station; at several points between Trenton and Lawrence a few cut twigs were noticed, but

near the latter place, on both sides of the road, the injury became very obvious. Between Lawrence and Princeton Junction there is one oak woods which seemed as if every tip on each tree were killed. A few cut twigs were seen near Princeton Junction, but between that point and New Brunswick no cutting that could be safely charged to Cicada was observed. It seems, thus, that in Mercer county the insects were pretty generally distributed, except in the extreme south, and that there was very little south of the line of the Pennsylvania railroad. The largest colonies are the southern continuations of the Hunterdon groups.

Somerset county adjoins Hunterdon on the east and Mercer on the north, and several colonies are reported. In the Crop Bulletin for June 17th, Mr. Jacob Wyckoff states that the first Cicada appeared at Middlebush on the 12th, while Mr. D. S. Campbell heard the first specimen at Martinsville on the 13th. In the issue for June 24th, Mr. A. F. Randolph states that at South Bound Brook the "English sparrows destroy locusts as fast as they appear."

June 5th, Mr. Wm. H. Skillman wrote me from Rocky Hill that the Cicadas had appeared in his vicinity, and "have brought all their relations with them." Mr. Dickerson made two trips to this place to collect specimens and secure examples of the chimneys that occurred there. At this place was the strongest colony in the county, and it petered out slowly, a few extending nearly to Franklin Park. At a farmers' meeting at the latter place, June 24th, I asked those assembled concerning the insect, and only toward Rocky Hill had any been noted. Mr. E. S. Davis, of the Class of '02, informed me that specimens taken in Bound Brook had been brought to him, and that they were said to be more abundant at Raritan. From Somerville they were reported by Mr. Peter Hardcastle, and, later, Mr. Arthur P. Sutphen informed me that a few specimens had been observed northwardly. From Neshanic came a report of a few specimens through Mr. James L. Garabrandt, of the Class of '01, and a student in my course. This joins the colony reported from Three Bridges, and indicates a scattered infestation along the lines of both the Lehigh Valley and Central Railroad of New Jersey west from Bound Brook. From Bound Brook to Somerville the sparrows probably took care of all that appeared. Harlingen and Kingston are added from Mr. Marlatt's records, and are extensions of the Rocky Hill colony. There is no record north of Martinsville, except a negative one from Basking Ridge. There are a number of good farming communities

in this northern section and I think it certain that I should have heard of it had the insects appeared in any number. Altogether, Somerset county was not very heavily visited except at one point.

Middlesex county lies just east of Somerset and Mercer, and, while the insects have come right up to the boundaries, I have few positive records of their occurrence within its borders. Under date of June 5th, Mr. Wm. Woerner recorded hearing the first Cicada at Piscataway town, and Mr. Woerner certainly knows both the insect and its song. June 12th, Mr. Dickerson covered the territory along the trolley line between New Brunswick and Metuchen, neither seeing nor hearing the insects. It is probable, therefore, that only stragglers occurred and that these were cared for by the sparrows. It is more than likely, also, that near Bound Brook, on the Raritan, a few examples occurred, but hardly any real colony. I have crossed Middlesex county by rail in every direction since July 1st without seeing anything of Cicada work. Mr. Marlatt has a record from Deans, where they are said to have occurred by the million, but I saw no traces of them myself, nor were they reported to me from that point. Late in October, while closely examining the trees in the Experiment Orchard, I found one twig on one apple tree which contained the characteristic punctures, so one specimen at least was very close to me for a time without my knowledge.

In Monmouth county a single colony appeared at the Highlands of Navesink, and so far was this out of the general course of the brood, that I questioned Mr. J. H. Willey, of Keyport, as to the correctness of his information. He replied, under date of July 5th, and insisted upon the correctness of his information. "I have seen several people from there and they all tell the same story." He adds that the insects were very numerous, and that seventeen years ago he saw them near Keyport, where this year they were not seen by him. Subsequently this report was confirmed by a number of persons, and the *Long Branch Record,* under date of June 13th, reported millions at Locust Point, near Oceanic, and in the hills leading to the Highlands of Navesink. It is curious that there should be a colony so far detached, but not more so, really, than some other of the occurrences of this brood.

South of Monmouth is Ocean county and almost on the line between Ocean and Burlington counties is New Egypt, whence Dr. G. W. Chamberlain reports a colony that extends into both counties. He wrote, under date of June 2d: "I have been making careful in-

quiry and learn that they were numerous from Collier's Mill across by old Zion church and north and east toward Prospertown (Ocean county). Also learn that between Jacobstown and Ellisdale (Burlington county) there was a colony." There is no other record for Ocean county, and I have crossed it on every line of railroad running through it without seeing any trace of injury to woodland.

From Burlington there is one other record, at Indian Mills, by Mr. Henry Wright. He wrote me, under date of July 1st, replying to my questions: "As to your inquiry about the Cicada, or seventeen-year locust, would say that they have been quite numerous only in certain localities—in Shamong township, in the vicinity of Naylor's Corner and what is called Forked Bridge Neck road. At each of these places there is from one to two hundred acres of young timber and they have been very numerous in this timber. They were also in the same locality seventeen years ago. I have not heard or seen any on fruit trees so far, and the last heavy rains have put them in shelter, somewhere." I have so many correspondents in Burlington county, that it is hardly probable that any other large colony could exist without my hearing it. I saw no traces of any in the woodland along the roads traveled by me.

Camden county, also, gives one record. Mr. Samuel Wood, Haddonfield, writes, under date of June 5th: "The Cicadas made their appearance on May 24th in the same locality where they did so much damage before (in Delaware township), and as yet have seen none in Haddon township. I was around the district where they are this morning; they were making lots of noise, but do not appear to be doing much damage."

Salem county has two colonies, not very widely separated. The first record is from Mr. Woodnut Pettit, of Salem, under date of May 31st: "Yes, we have lots of them, if you go to the right place to find them—that is, in the timber land. This is the fourth time I have witnessed their visitation—1851, 1868, 1885 and now. I never knew them to do any damage to nursery or orchard trees where the young trees had been set or planted on lands that were not occupied as forest or timber land seventeen years previous. If at that time they were, and the forest had been cut off since, why, of course, when they came to the surface they would immediately alight on the orchard trees and commence reproduction, etc. About two miles east from my farm during the past fifty years there has been a large tract

of timber land, which is, unfortunately, gradually becoming exterminated. This tract at each visitation of the Cicada has been infested with millions of the insects and, with an east wind, you can hear them sing all day; yet, notwithstanding this fact, I have never, with the possible exception of 1851, been able to collect half a dozen specimens on the farm, and don't expect to find any this year, either. I am satisfied that, if they have satisfactory feeding and breeding places when they arrive, they will not migrate therefrom."

I have quoted Mr. Pettit's letter very fully, because, not only has he observed an unusual number of broods, but he has hit very closely the conditions under which injury is likely to occur.

June 6th, when sending specimens, Mr. Pettit wrote: "I have seen them to-day so thick that small twigs would bend over with the weight. Not having had any rain here for some weeks sufficient to fill the holes they made in coming out of the ground, they were very plainly seen wherever you looked for them—hardly a square foot of ground but what has been punctured by them."

June 7th, Mr. M. D. Dickinson wrote that the "Cicada made their appearance near Yorktown, in Salem county, about three miles from Woodstown, and that they were very numerous." On the 10th the Crop Bulletin contained a report that the insects had appeared at Woodstown, and this closes my records from Salem.

Gloucester county is just north of Salem, and, while I have no records myself, Mr. Marlatt sends references to newspaper reports of their occurrence at and near Swedesboro and in the woods between Harrisonville and Swedesboro. This is in line with the Salem colonies and extends the range a little farther north. I saw nothing of the insects near Paulsboro nor anywhere along the line of the Penns Grove branch of the West Jersey railroad. The county is tolerably well settled, and had the insects appeared at all generally, I believe I should have heard of it. I have crossed the county on every line of railroad that runs through it and saw nothing of Cicada work from the cars.

Cumberland county has one colony, near Shiloh, in the same general territory with the Salem areas of infestation. This colony was first reported in the Crop Bulletin for June 10th, by Cora M. Sheppard. It was next referred to, under date of June 13th, by Mr. Thomas Hunt, who wrote from Greenwich that the insects had not been seen or heard in his township. "The nearest record is at Shiloh, five miles distant."

In a question of distribution, particularly of an insect likely to prove injurious, it is often as important to know where not to expect it. Hence, negative evidence has been as diligently sought for as was that which actually recorded the presence of the insect.

Based upon such evidence, it is quite certain that the Cicada occurs neither in Hudson nor in Essex counties. There are numerous collectors of insects in both, and it is almost impossible that the insects could have occurred and escaped notice. In Hudson county areas of possible occurrence are limited, and I feel very certain that no specimens were present. In Essex county the wooded slopes of the Watchung or Orange mountains would seem to offer excellent opportunities for the insects; but this a stronghold of brood XII., which appeared in 1894, and the same men who recorded that brood for me so thoroughly reported positively that no trace of the insects was found this year. These reporters include members of the Newark and New York Entomological Societies, who would almost certainly have noted the species had it occurred, and all these made negative statements. I may add that I have myself covered a considerable part of this county without finding any trace of the insects.

For Bergen and Union counties almost the same may be said. Bergen county has a number of excellent reporters, who kept a sharp lookout, and nowhere was there any appearance of the insect. In a few cases in Bergen county young orchards had been left untrimmed, in accordance with my suggestions; hence, the owners had a very strong interest in the matter, that made them anxious for any information, positive or negative.

In Union county there are a number of good observers, who would have, almost certainly, noticed the insect had it occurred, and I personally crossed the county in several directions during the season without either seeing or hearing of it. It should be noted that none of the four counties mentioned was included in the circular sent out in September, 1901, as having been covered by previous records.

Passaic and Sussex counties are blanks in my record, and so is Morris. All three of these are mentioned in my circular as having been referred to in previous publications concerning this brood.

Passaic and Sussex counties are well north of any definite reports concerning this brood. For Passaic I have nothing, one way or the other; but parts of the county are so well settled that the insects could not have escaped notice had they appeared. Brood VIII. is well recorded from this county.

In Sussex I have one negative report from Deckertown (Sussex). Mr. Samuel A. Miller reports none appearing and that none are due. I saw no signs of any on the shores of Lake Hopatcong nor on the road to Edison; but there is a considerable area in this county that is not well covered and it is not improbable that colonies may exist on the wooded hillsides.

Morris county is almost in the track of the brood across the State, but all my records are negative. Such records come from Morristown and Chester (Dickerson), and I personally visited Morristown on two occasions, when any appearance of Cicada work would certainly have attracted my attention. There is no appearance of injury to woodland along the lines of either the Delaware, Lackawanna and Western or the Central Railroad of New Jersey, through this county. Mr. Marlatt sends me a record of their occurrence near Boonton, which is farther north than any other in the State, and which I have not been able to verify.*

Briefly stated, if we draw a straight line across the map of the State from Rahway to Belvidere, there is no record of Cicada north of that line.

Neither Atlantic nor Cape May counties record the brood and neither is mentioned in my circular. In Atlantic county, Mr. L. Monfort, of Hammonton, and Mr. Henry Pfeiffer, of Cologne, both report that they could hear of no Cicadas after diligent inquiry. Brood VIII. is the one known there. Personally, I have crossed the county on the West Jersey and Seashore and Atlantic City railroad to Atlantic City, and from Winslow to Tuckahoe, without noting traces of injury in the forest. It is fair to assume that the insects did not occur here. Cape May county sends no records of any kind, and I have traveled the county on both the railroads to Cape May City without noting any signs. During the time spent along shore on the mosquito investigation I met many persons from this county who would have been able to inform me of the appearance of the insects had they occurred. Woodbine suffered seriously in 1894, but I was positively assured by a resident that nothing was seen of the Cicada this year.

I think it is fair to claim from the above records, positive and negative, the distribution shown in the map printed herewith. The map also shows the distribution of the other broods and gives a fair picture of the overlapping of colonies in some localities.

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* The editor of the *Boonton Weekly Bulletin* states positively that the insects did not occur at or near that place.

A New Classification of Broods.

Late in 1898 Mr. C. L. Marlatt, of the Division of Entomology of the United States Department of Agriculture, after a careful study of all the records, proposed a new enumeration of the broods, recognizing the existence of some that had not been previously defined. One of these new broods, under XV. (1890), occurs in New Jersey in small numbers. Several of the members of the Newark Entomological Society brought me specimens taken in Essex county, and I noted the species at Anglesea, Cape May county. It was supposed at that time that these were delayed members of the brood VIII., and no effort was made to learn if the insects occurred elsewhere. Mr. Marlatt, however, found records from New York and North Carolina, which indicate a distinct brood, whose colonies are widely scattered.

As rearranged by Mr. Marlatt, the New Jersey broods are—II., last occurring in 1894 (XII. of the old style); VI., last occurring in 1898 (XVII. of the old style); X., occurring during the present year (XXII. of the old style); XIV., last occurring in 1889 (VIII. of the old style), and XV., last occurring in 1890, for which there was no previous number.

For convenience, the old style of numbering has been retained in this record; arranged in a different form the broods are as follows:

Riley's	brood VIII. (1889)	=	Marlatt's	brood	XIV.
"	no number (1890)	=	"	"	XV.
"	brood XII. (1894)	=	"	"	II.
"	" XVII. (1898)	=	"	"	VI.
"	" XXII. (1902)	=	"	"	X.

Injury Caused.

Only from Hunterdon county, the chief infested area, have I had any reports of injury caused by this insect to shade or orchard trees. It has been quite remarkable how generally fruit trees escaped, even where the insects were plentiful. In several places I saw wood-covered hillsides, where almost every deciduous tree showed broken or dying twigs; the apple trees in the orchards almost adjoining the wood showed no traces of injury. The explanation given in Mr. Pettit's record is in accordance with this observation. The insects do not voluntarily travel much, and do not, ordinarily, get out of the patch of woodland in which they appear. So long as they have plenty of food and plenty of room for laying eggs they do not spread. Where

woodland has been recently cut off and fruit trees have been set, injury has come because the insects came up near the trees and found them convenient for their purposes. Except in Hunterdon county, there is little such recently-cleared land in orchards in the infested area.

An interesting account of his experience was supplied by the Rev. F. J. Tomlinson, of Pittstown, under date of September 1st, 1902. He says: "They came on in veritable droves every warm night for about three weeks. I have a small orchard of about seventy-five trees. I thought to keep them off at first, so just as it was growing dark I would take a large bucket (holds about four gallons) and a stick and sweep off those that were ascending the trunks. I would get the bucket three-fourths full by the time I went over them. I did it a few nights, then gave up in despair. * * * The greatest damage for us was to a young apple orchard, two years old, in which many trees were stung so badly that I cut off the entire top. I do not know whether they are worth saving—about a hundred trees. We have also a peach orchard, two years old, which is badly stung. In some cases I have trimmed out all stung branches, and that leaves a badly-shaped tree, for they seemed determined to sting the strong main shoots. * * * Now, I will tell you something about my young chestnuts: I grafted 1,066 and have 475 growing. * * * The locusts did considerable damage to both stocks and grafts. I tried cutting out the eggs, but that so badly mutilated the stocks that it is a problem whether the remedy is not about as bad as the disease. One thing, I think, was greatly in our favor—that was the cold, wet weather that prevailed much of the time while they would have been most active. But for that, it seems to me, they

Fig. 3.
Cicada punctures showing, at *a*, how the twig breaks. After Riley.

would have made almost a clean sweep of all our young stuff. They did kill a number of young grape vines for us, and also young English walnuts. I was among my young chestnuts much of the time during the two or three hottest days, when most of the damage was done, and kept them from doing as much damage as they would. It takes them a little time to get down to business, and before much was done I would be around with my protest, which was generally a good squeeze."

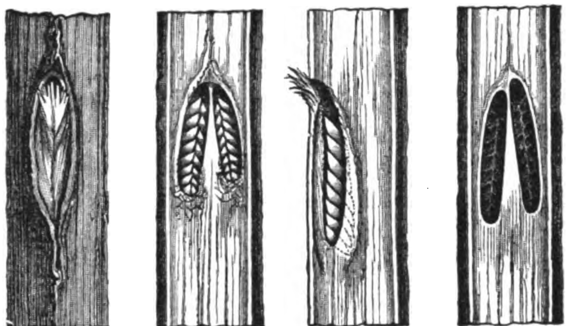

Fig. 4.

Cicada egg puncture: *a*, as it appears outwardly; *b*, cut through the face of same; *c*, cut from side, showing a single cell with eggs in place: *d*, cells emptied of eggs; somewhat enlarged. After Riley.

As to the character of the injury, that is shown in Figures 2 and 3, from my Report for 1894. The females, by means of their augur-like ovipositors (Figure 5), cut slits into twigs and branches, usually toward the tip and in new growth; yet, sometimes in older wood, and even in the trunks of young trees. These slits are made to hold the eggs and they go deep into the tissue. The twig or small branch is much weakened thereby and a high wind twists or breaks it. It drops or, most usually, hangs for a time; a sure index of the recent occurrence of this species. Sometimes the nutrition of the shoot is so interfered with that, even if it does not break, the foliage dies and the mark is as conspicuous as if there had been an actual break.

The eggs laid in the slits hatch during August and the young larvæ at once drop to the ground and burrow out of sight.

That the adults do some feeding is now pretty well established, but it is so little that practically no harm is done in this way. The larvæ grow so slowly and feed so little that that does not injure the infested roots. It is only in the act of egg-laying that the female does injury to growing plants.

In the forest this is only a summer pruning and is readily outgrown. In the orchard or nursery matters are more dangerous, especially on young trees, which are sometimes crippled.

Life History.

The life history of this insect has been written in previous reports, and in that for 1894 some structural details, with the peculiar chimneys or cones, were described and figured. The egg-laying habits are discussed in a previous section. After the larvæ hatch from the eggs and drop to the ground, they make their way below the surface and attach themselves to the roots of trees and shrubs. They may go down along these roots for a considerable distance and are rarely found near the surface much before the time when they are due to appear as adults. They do no real injury in this stage, growing as slowly as they do, and feeding so little. Sixteen full years are required to bring them to the point which, on the seventeenth, they attain when adult.

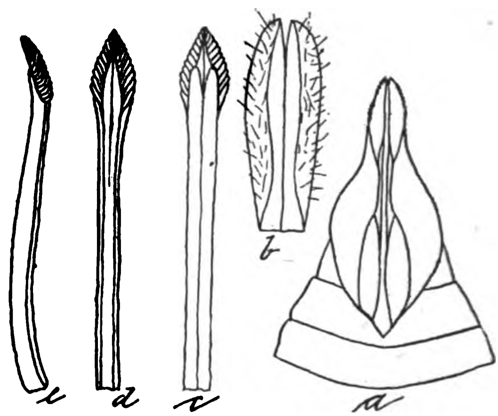

Fig. 5.

a, end of female abdomen from beneath; b, sheath inclosing tip of ovipositor; c, ovipositor from below; d, same from above; e, same from side—enlarged. Original.

The song produced by the males and the ovipositor of the females are explained in the 1894 Report. The song is really the rapid vibration of a stiff, convex membrane, the sound intensified by other thin membranes acting as sounding-boards. The females, which do not sing, have been accused of stinging, but a reference to Figure 5 will readily show that the "sting," while excellent for boring into wood, is hardly adapted for the rapid piercing of a muscle.

Fig. 6.

The Fumigating Box at Parry. From an original photograph.

Remedial Measures.

There are none that are reliable when these insects are abundant. Whitewash comes nearest to being a preventive, since they do not like to rest on a white surface; but even this fails when proper, uncovered twigs are lacking.

We can only, when we know that the species will occur, arrange our orchard practice so as to leave plenty of growth for them and no young trees to tempt them.

Forecast.

This brood is due to reappear in 1919, and it will at that time be much reduced in extent. Wherever it appeared near towns or villages where the sparrows are dominant, the probabilities are that it will not reappear. The southern colonies are all much smaller and less extensive than they were seventeen years ago, and it is likely that some of them will disappear altogether. The strongholds of this brood are in Hunterdon, Mercer and Somerset counties, and to these it will, very probably, be confined on its next appearance. It is very unlikely that it will be my pleasure to record this brood again.

FUMIGATION.

Fumigation, as this term is used here, is the process of submitting nursery stock to the action of hydrocyanic acid gas in an airtight box or chamber for a length of time sufficient to kill insects without causing injury to plants.

Hydrocyanic acid gas is produced by the action of dilute sulphuric acid upon fused cyanide of potassium, and the gas thus liberated is intensely poisonous to all animal life from man down. Cyanide of potassium is itself a deadly poison, and sulphuric acid is a violent corrosive; therefore, the first point in connection with this process is the absolute necessity for care in its use.

The materials themselves must be of good quality to produce the best results; much of the imperfect work done when the process was first developed being due to the impurities in the cyanide, the acid or in both.

The cyanide of potassium must be 98 per cent. pure and the sulphuric acid should have a specific gravity of 1.83 or be of the best

commercial grade. Chamber acid will not do. Any reliable firm of dealers in chemicals can supply both of these materials. The Roessler & Hasslacher Chemical Co., 100 William street, New York City, has made rather a specialty of supplying the proper grade of cyanide at the lowest prices, ranging from thirty-two to thirty-five cents per pound, according to quantity. Sulphuric acid is so generally used in the arts that the proper grade may be easily obtained from any drug or chemical company.

To produce the gas there should be one part by weight of the cyanide, one and one-half parts, by measure, of the acid, and three parts, by measure, of water. This would be expressed in the following formula:

Cyanide of Potassium, 98 per cent. pure	1 oz.
Sulphuric Acid, Commercial (sp. gr. 1.83)	1½ oz.
Water	3 oz.

This formula will be considered standard for the purposes of this paper, and hereafter only the amount of cyanide will be given, leaving the amount of acid and water to be figured out on the basis above given. Any glazed earthenware vessel may be used as a generator. Metal receptacles of any kind corrode rapidly and wooden vessels char. Glass will answer as well as earthenware, but is apt to be more expensive and is more liable to break.

In preparing to fumigate, always weigh out the cyanide first and place it in small lumps in a thin paper bag. Where the fumigating charge is always the same, it is well to weigh out the cyanide into bags at the beginning of the season, as this will make it easy to pick up a bag whenever needed without the delay of weighing out. Keep the bags in closed boxes or jars, as the action of the air deteriorates it. Put the proper amount of water into the generator first. Then add the acid slowly and, when the two have united, drop in the bag of cyanide and close the box, chamber or house. The order given is important and should be closely followed. The combination of sulphuric acid and water produces heat, and the mixture, when complete, will be hot or warm, according to the rapidity with which the acid was poured in. Pouring the acid into a larger body of water warms this up gradually and only a little steaming or boiling appears. Should water be poured into the acid, so violent a boiling would take place when the first few drops of water combined with it that there would be a serious splashing that might cause breakage of the jar or a scat-

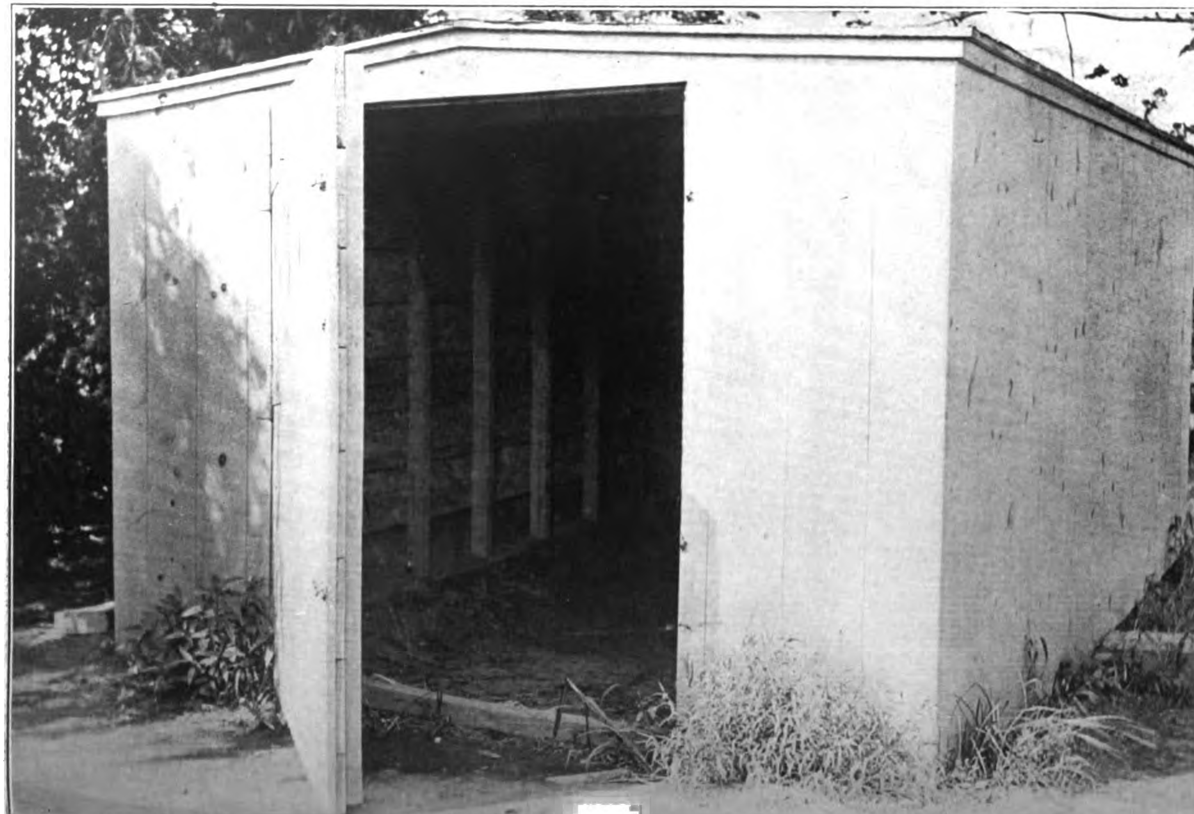

Fig. 7.

The Lovett Fumigating House. From an original photograph.

tering of the material. Therefore, always measure out the water first and then pour the acid slowly into the water. By dropping the cyanide yet inclosed in the paper bag, the formation of the gas is retarded until the liquid penetrates the paper; a few moments only, but long enough to make it possible to close the box or room and thus prevent loss of gas.

Orchard fumigation is not deemed feasible at present for New Jersey conditions, and no detailed directions for such work will be given here, but some general suggestions may be useful and will be given later in this paper. For the first, nursery conditions only will be considered, and the day is not far distant when fumigation of stock will be a matter of routine on every well-conducted establishment. In New York and some other States, fumigation is absolutely required at all nurseries, and there is no doubt that this forms an element of protection to the purchaser that is of the highest value.

In New Jersey fumigation is not required by law, but as stock must be fumigated to admit it into some foreign States, most of those doing other than a local trade have built more or less suitable boxes or houses. The first box built in this State was at Parry, and a picture of this is given herewith, reproduced from my Report for 1897. The box was well built, entirely suited to its purpose and was a model for a number of others used on small nurseries. The stock was here piled into the box on a slat floor, keeping it well above the ground, the cover was firmly fastened down and the chemicals were placed in a small drawer, which opened out at the middle of the front. When the jar was properly charged the drawer was shoved to the middle of the box, the lid to the outside was dropped into place, covered with heavy blanketing and weighted to make a tight joint.

The only objection to this box was its small size and the relatively great cost in time and labor of treating the stock of a large nursery.

Experiments with the gas were now in progress in several States, and no one did more to develop the practical usefulness of the process than Professor W. G. Johnson, at that time in Maryland, and now on the staff of the *American Agriculturist*. His book on the subject is a standard and necessary to all who would understand the application of the method to all sorts of plants under all sorts of conditions. I have drawn upon this book for such of the information here given as is not within my own experience.

The first house of any size was built on the Lovett Nurseries, at Little Silver, and there is not a better-built house for the purpose

anywhere in the country. It is as nearly air-tight as such a house can be built, and the door, closing like a refrigerator door, against a felt seat, and held in places by cleats that tighten like a wedge, makes it a perfect "fumigatorium."

The largest house at present in the State is on the Village Nurseries, at Hightstown, and this was built to accommodate the needs of a very large establishment. An entire wagon load of trees is here fumigated at one time, the gas being generated on the floor and getting an excellent chance to diffuse throughout the mass. The effectiveness of this house was tested by placing some very scaly trees in the midst of a load and then setting them out in a remote corner of the farm. They all grew and not a scale developed on any of them at any time during the season following.

There is no need to show in detail other houses, since, in their essentials, they are alike; but it will be interesting to show for comparison a picture of a fumigating-house in Georgia, which I owe to the courtesy of Mr. W. M. Scott, the State Entomologist and chief inspecting officer of that State. No house in New Jersey, so far as I know them, has more than one room. The one shown here has three, differing somewhat in size, and the house can be kept constantly going during the shipping season, while, if only a small lot of stock needs treatment, the smallest room can be used. During the season when no fumigating is done, the building is very useful for a variety of purposes.

Enough has been said and shown to indicate that no one type of house is essential; but every house, to be satisfactory, should have the following points:

First. It should be as nearly air-tight as possible; any building through which daylight is visible when the doors are closed is a mere evasion and make-believe, from which satisfactory work cannot be expected. To be really safe the house should have double sides, with building-paper between, and a match-board ceiling. The sills should be imbedded in the soil and the outside sheathing should be closely joined, to cover them to the surface. The roof may have any pitch, but it will be better to have a flat ceiling to the room, as it will require less material to fumigate.

Second. The doors should close over a broad ledge, guarded by felt, against which they can be tightly pressed by any suitable contrivance. So, there should be some provision to make a tight joint at bottom.

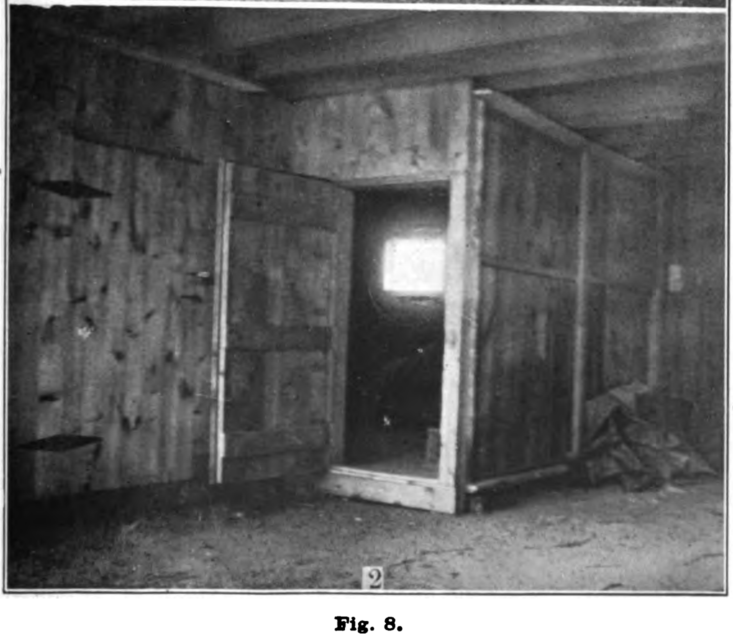

Fig. 8.

1, The Fumigating House at the Village Nurseries; 2, Fumigating Room at the Pleasant Valley Nurseries. From original photographs.

Fig. 9.

A Georgia Fumigating House. From a photograph supplied by W. M. Scott, State Entomologist of Georgia.

In a house like that on the Village Nurseries this is obtained by shoveling sand to cover the joint when the door is closed.

Third. There should be a slatted floor, raised from six to twelve inches above the ground level, so as to allow a free circulation of gas below the mass of stock piled above, and the jar containing the cyanide, etc., should be on a level below that of the slat floor. If the stock is on a wagon, the floor of the wagon body should not be too solid, but in that case no slatted floor is needed.

These may be considered the essentials of a really satisfactory house. A very desirable addition is a method of allowing the gas to escape rapidly, after the stock has been exposed to it for a sufficient length of time. This is usually accomplished by means of a window opposite the door, that may be opened from the outside. It should close as tightly as the door, with a solid shutter. Experience has shown that if light be excluded the gas is more fatal to insects and less dangerous to plants. Therefore, though a glass sash may be inside, there should be a solid shutter outside of it. An even more effective ventilation is a heavy door in the roof, that may be lifted by means of a pulley from the ground before the doors are opened. In opening the doors care should be taken not to get the first rush of gas from the house. Headache and vertigo have followed carelessness on this point and worse results are not excluded.

The place for the jar with the fumigating material is in the centre of the house, unless it is so long that two jars are desirable. A house over fifteen feet long should have two jars in the mid-width, but at one-third from the back and front. It will be easy to rig up some sort of contrivance to suspend the cyanide bags over the jars until the door is ready to be closed, or they may be balanced on a narrow strip, so as to be readily shoved into the jar by means of a long rod. Where only a single charge is needed, a passageway may be left from jar to door, and, after dropping the bag into it, a rapid retreat to the door may be accomplished before gas is generated.

Given a proper construction and the necessary arrangement for generating the gas, the house may be completely filled with stock from slat floor to roof. It should not be tied in tight bundles, but need not be too loosely placed. Give the gas a chance to circulate and allow nothing on the plants that might shelter or cover the insects.

Time and Quantity.

Only dormant stock should be fumigated, and evergreens (conifers) should never be exposed to the gas. Practice has shown that, except for peach and plum, one ounce of cyanide for every 100 cubic feet of space is a safe mixture, and that the trees may safely remain exposed in the house during the night. Good peach and plum stock will stand the same charge for an hour with safety, but may suffer if allowed to remain over night. Three-fourths of an ounce has proved safe for an all-night exposure. It seems to be the conclusion of those who have studied this point most carefully that a large volume of gas for a short time is more effective against insects and safer on trees; hence, one ounce of cyanide on peach, exposed not over an hour, is better than three-fourths of an ounce exposed all night. It has also been proved that the pernicious scale succumbs to the gas, if perfectly diffused in sufficient quantity, in half an hour and at a minimum of three-fourths of an ounce to 100 cubic feet of space. This latter charge—three-fourths of an ounce of cyanide to 100 cubic feet of space—with an exposure lasting forty minutes, should be used for June-budded peach, for weak, imperfectly dormant stock and for buds, grafts and scions. These should be loosely piled, to allow the rapid diffusion of the gas.

Perhaps this is a good place to say that no tree known to be scaly should ever go into the fumigating house with the idea of sending it to a customer who expects to get clean trees. Fumigation is a process that is meant to supplement inspection and not to replace it. It is as near perfection as we may hope to get, but is no more infallible, even when done with the utmost care, than any other process known to us for any purpose.

It is sometimes supposed that if one treatment is good, two of the same kind ought to be better, but this does not apply to fumigation, and trees known to have been once treated should not be submitted to a second application; and especially is this true of peach. Nor should trees be treated when they are wet. The gas seems much more injurious to them in that condition and I have seen apple and pear come out of the house and grow lifeless and soggy almost at once. Moisture is not needed to assist the action of the gas, but a little dampness is not necessarily harmful. Never should the trees be laid directly on a damp, earthen floor. The gas could not get at the surfaces in direct contact with the soil.

After fumigation there will remain in the jar a liquid or pasty mass which crystalizes if left for some time. This residue should bĕ buried or disposed of in such a way as not to get into the way of animals. It may be placed in the manure pit, adding as it does a little potash and sulphuric acid.

Range of Effectiveness.

Fumigation as at present practiced is primarily directed against the pernicious scale; but it is powerfully effective, also, against many other insects not in the egg stage. It will not rid nursery stock of either oyster-shell or scurfy scale because these winter as eggs under the scale covering. It will not kill eggs of the apple plant lice at ordinary exposures, nor any other egg masses that may be on the stock. It will kill peach root lice, woolly lice on apple and other stock, blister mites on pear, pear psylla and any insects in the larval, pupal or adult stage that may be wintering on the stock.

It is by no means a cure-all, but it does reach more species than any one other process that is known to us, and the nurseryman that sends out a fumigated tree does better for his customer than one who does not, even though the latter had no trace of "scale" in his nursery.

Other Fumigating Devices.

It sometimes happens that a nurseryman has only a carload or two of trees and does not wish to build a fumigating house or box, and from such I have met the question again and again whether the stock could not be fumigated in the car. It can be done if the car is used as a house would be and is cleared of the gas before the trees are finally packed. But if the car is loaded with stock bundled in the usual manner—roots protected by wet moss, etc., and the fumigation is done just before sending off—the chances are that material injury to the stock will be caused. A box freight car does not ventilate easily, and the gas may remain banked at the ends for some time, causing injury. The wet roots will tend to absorb the gas and injury is here likely, while, finally, the chances for the scale insects to escape the action of the gas are very much increased.

The simplest way to fumigate stock is to pile it on a rack, cover with oiled canvas, bank up with soil over the canvas at bottom and then place the charge beneath it. This was the Californian method

some years ago and yielded very good results; but it is uncertain in its effects upon both plants and insects and is not to be encouraged. Accurate determination of the amount of cyanide necessary is difficult, while material error one way or the other may mean death to the plants or life to the insects. In order to make the process at all allowable, the canvas cover must be gas-tight.

Orchard Fumigation.

This point has been touched upon. For small trees in a young orchard or for dwarf trees, fumigation is entirely practical and effective. I am quite aware that very large trees are fumigated in California, but there individual holdings in orchard far exceed anything that we have in New Jersey, and expensive outfits are good investments. Furthermore, California is so much a horticultural State that county or other local authorities own outfits for the benefit of their constituents, while the amount of work to be done is sufficient to make it also worth while for private enterprise to invest the necessary capital for the outfit that enables them to contract to do it.

Orchard fumigation in New Jersey is best done in fall, when the foliage has served its purpose and while the scales are not yet tending to become dormant. The essential for successful practice is a gas-tight cover of some sort that will serve to enclose the tree while it is subjected to the gas. All sorts of boxes and tents, portable, adjustable, fixed and knock-downs, with all sorts of contrivances for placing and removing them have been invented, tried, improved and perfected. An excellent account of the different forms of tree covers is given by Professor Johnson in his book on fumigation, but it means in effect that there should be a cover of eight-ounce oiled duck or a box of thick building-paper, so put together as to be gas-tight when placed over the tree. The charge for such fumigation is four-fifths of an ounce of cyanide per 100 cubic feet of space, or in that proportion, and the time of exposure is from thirty to forty-five minutes.

Greenhouse Fumigation.

On this point I have no personal experience whatever and base the suggestions made here upon either results obtained by Dr. A. F. Woods, of the Division of Vegetable Physiology and Pathology in

the United States Department of Agriculture, or upon the records contained in Professor Johnson's book, already cited.

First of all, it will be necessary to determine very accurately the cubic contents of the house; next, it will be necessary to make it gas-tight, while also providing that some ventilators may be opened from the outside, to permit the escape of the gas. The plants must not be wet, nor must the floor of the house be wet, but it may be damp. Moisture intensifies the action of the gas on the plants and so does light; therefore, greenhouse fumigation should be done only at night.

Under these conditions one ounce of cyanide to 300 cubic feet of space is safe on ferns, while killing the scales which infested them in twenty minutes. Coleus infested with mealy bugs were cleared in the same time, using one ounce to 250 feet, while double English violets were cleared of all save red spider by increasing this dose to one ounce in 175 cubic feet. Single violets are more susceptible, and will not stand more than one ounce to 250 feet. Tomatoes were cleared of white fly by using one ounce to 1,000 cubic feet and retaining the fumes all night. Lice were cleared from melons by fumigating all night with one ounce of cyanide to 175 cubic feet. Roses, carnations and chrysanthemums have not been safely treated.

Enough has been said here to put the owner of a greenhouse upon inquiry. The subject is yet in its infancy and will repay experimentation. Professor Johnson's book should be carefully studied and the strong point mastered, that when the grower has once fully determined what his plants will stand safely, he has the insect enemies of these plants entirely at his mercy.

Small Fruit Fumigation.

In the discussion of methods of fumigating "nursery stock," that term has been used as applying only to tree stock. As a matter of fact, all the usual hardy, shrubby plants and small fruits, such as currant and gooseberry, may be treated on the same basis as peach. But plants like strawberry stand on a somewhat different footing. Strawberries are not subject to San Jose scale attack, but they are subject to infestation by a root-louse, that sometimes causes serious injury; hence, some States demand that strawberry plants shipped within their borders should be fumigated.

In Bulletin No. 149 a box for fumigation of this character is figured and described. The figure is reproduced here as Figure 16, and the description of the box and how it is to be used is as follows: "This box is 2 x 2 x 2½ feet, without a bottom, made of two thicknesses of matched wainscoting, with building-paper between; the cover closes upon a rabbet the depth of the thickness of the material and lined with felt; a small door, about 6 x 6 inches, is placed at the lower corner and similarly fitted so as to close on the felt; four or five frames, covered with wire netting, rest upon cleats, the lower one being about three or four inches above the ground and extending to the small door, and the rest of the trays extending clear across the box, being about five inches apart. Such a box will hold from 1,500 to 2,000 loose plants, placing only one layer on a frame, which permits a quick and thorough diffusion of the gas. The only apparatus necessary is a cup or tumbler in which to generate the gas."

This box contains ten cubic feet, and requires forty-five grains of cyanide for a ten-minute fumigation. For such small quantities, the cyanide, which must be 98 per cent. pure, is best dissolved in two drachms of water, and this had better be done by a druggist, who can make up, in separate vials, as many doses as may be needed. There should be an equal number of vials of the best-grade commercial sulphuric acid, each containing one and one-half drachms of the acid.

When ready for work, place the box on a level spot so it rests solidly all around, bank up on all sides to six inches or more and pack firmly. Place the plants upon the trays in single layers, close and fasten the top, uncork the vial with the cyanide solution and put it mouth downward into the cup; immediately thereafter drop in the acid in the same way, shove the cup into the box through the lower opening, close the door tightly and keep closed for full ten minutes. Then lift the top and allow the fumes to escape before taking out the plants.

A box of this kind will answer excellently well to fumigate buds, grafts or scions, but the time must be increased to half an hour in such cases. It goes without saying that this kind of box may be increased in size to any desired point, as circumstances may demand. What is given here is the principle to be kept in mind and a basis upon which practice may be founded.

Other Objects for Fumigation.

It sometimes happens that dwellings become infested with household pests unpleasant in character, and the question of how to deal with them becomes a matter of real importance. On this point the experience of the South African Cape Town railroad, as recorded by the official Entomologist, may be of interest. The habits of some of the patrons of the road were such that the passenger cars became infested with bed-bugs to an intolerable degree, and the Entomologist was appealed to for help. He suggested the construction of a room large enough to contain a car and tight enough to hold gas. His suggestion was followed and the results were perfect. Car after car was cleaned at very little cost in money or trouble, and the bug problem is solved for that company.

It happens, sometimes, that an old house becomes so infested by vermin that ordinary means fail of their usual effect. Heroic measures must be resorted to, and the best of these is hydro-cyanic acid gas. Any room can be completely cleaned of all undesirable guests by fumigating with this gas at the rate of one ounce to 100 cubic feet of space. Of course, the room must be unoccupied, and there should not be any unnecessary hangings, curtains or draperies of any kind. All closets, doors and all drawers must be open, all furniture moved away from the walls, and the windows made as nearly tight as possible with cotton or other stuffing. Nor will one application be sufficient. It has been stated that the gas does not kill insect eggs, and, as eggs of the household pests may be present, a second fumigation, a week or ten days after the first, is necessary to make certain of complete results. The gas should be allowed to act for full twelve hours, if possible; and it will, in that time, reach all roaches, as well as mice and other vermin that may be in its way. Room after room may be so treated and the entire house cleaned out.

Other cases where this gas will prove useful may occur, and what has been already said will be found applicable to these as they arise. It should always be kept in mind, however—*first,* that this gas is a deadly poison for animals of all kinds, promptly; and for vegetation, in a litle longer time; *second,* that to exercise its effect it needs a confined space.

CRUDE PETROLEUM.

This has been, on the whole, the main reliance for keeping in check the San Jose or pernicious scale during the period that has elapsed since the last report. I have made no new experiments and have nothing to add from personal experience; but I have seen many sprayed orchards, have had written reports from many others and have had verbal reports from growers all over the State. The value of an insecticide as such may be determined by laboratory tests and by applications under careful supervision and control; but its practical usefulness is determined by its effect in the hands of the man who applies it in a commercial orchard under ordinary farm conditions.

For my own use, undiluted crude petroleum of the proper character (43° or higher) is preferable to any other material. In the hands of many of our orchardists it has approved itself excellently; but there is an element of danger that increases as the necessity for entrusting its application to ordinary farm help arises, and this cannot be ignored. It has proved, too, that the liability of a plant to injury depends somewhat upon obscure conditions within itself, or upon climatic conditions which we have not appreciated as yet. Hence, the tendency has been to abandon the undiluted applications in favor of emulsions or mechanical mixtures containing 20 to 25 per cent. only of the oil.

These mixtures have been very largely used in some of the Southern States and form their main reliance at present. In Georgia, the emulsion is given first place over the mechanical mixture because of the possibility of more even applications.

It seems remarkable that even pumps made under modern mechanical conditions should have an individuality, but so it is, and while some emulsion pumps work evenly and well, others are absolutely not to be depended on. This is not a difference in makes of pump, but between pumps of the same make, and a cranky pump is almost as unreliable in the hands of a good mechanic as of an ordinary colored farm help.

The question of cost is always an important matter, hence the following report will be of interest:

"My Dear Sir—I took the advice contained in your letter of January 7th and purchased a Gould's Kerowater spray pump. Owing to the first machine being lost *en route*, I did not receive the second

until near the middle of March. Began spraying 25 per cent. mixture March 14th, and worked steadily, on favorable days, until March 31st. Some of the oil was marked insecticide oil and other barrels crude oil.

"Used six barrels oil on seventeen acres—about one barrel to three acres on about 1,900 trees, or about one and one-third pints per tree. Trees mostly peach, five and six years old. Some peach sixteen years, others one year, and a few apple trees. The pump worked very nicely, and after organizing the spraying party I had no further trouble. Of course, the cost of pump, oil and time was considerable.

Cost of spraying outfit	$22 50
Six bbls. oil, net	26 25
Labor	27 00
Incidentals	1 00
Total	76 75

Cost per acre, $4.50; cost per tree, four cents. Deducting two-thirds of cost of machine, the cost per acre would be about $3.50. The cost per tree would be three and one-quarter cents. We sprayed with the wind, using Vermorel nozzle, doing the other side on change of wind.

"The outfit in the field was as follows: Two-horse team and farm wagon, containing two men, one to drive and pump, one to spray; spraying barrel, one oil barrel, tapped, and one water barrel; starting from place in morning and at noon, with machine filled; carried through one-half day. Strained all the oil and all water used from brook or spring.

"If the 25 per cent. mixture proves to be effective, it would be a considerable saving. I could not have gotten along with less than twenty barrels of undiluted oil, as the trees are large.

"Owing to delay in receiving my pump, I had to spray in windy weather, and did not do a perfect job. The latter part of February this year was altogether unfit to spray, owing to snow, ice and fallen limbs and branches. The first part of March was the best time, just before my pump came. The latter part was windy. Seasons vary greatly. I think December would average a good spraying month.

"P. S.—The labor charge above noted is the minimum. Allowed only $1 per day per man and fifty cents per day per horse. As I sprayed in the busy pruning and trimming season, I should have increased labor 25 per cent. at least. If the work was done in favorable midwinter weather, the cost would not be any more than I stated,

as a small force of men and all horses have to be kept throughout the winter."

The results of this application were reported upon under date of September 25th, as follows:

"You may recall a report of spraying 1,900 fruit trees I made to you April 8th, and will, without doubt, be interested in knowing the experiment was a success from a commercial standpoint.

"The greater part of the peach trees were five and six years old, constituting a twenty-acre orchard. The trees were affected by the scale from the time they were set out, and I gradually kept taking out parts of the orchard until this spring, when there was a six-acre cleaning in the middle and the remainder of the trees somewhat more than decimated. Many of the trees left standing were apparently worthless, and were left in place to complete the rectangles and simplify cultivation.

"I sprayed during the month of March all of the trees in the five and six-year orchards, also in one and sixteen-year peach orchards and a few young apple trees, with a mixture of about 20 or 25 per cent. of crude oil and 75 or 80 per cent. of water, using a Gould's pump. Within six weeks the appearance of the trees was greatly improved; the bark appeared as if it had been cleaned.

"There has been a half crop of peaches, very uniformly distributed over the entire orchard. Not a tree overloaded and none without fruit, excepting those trees which were so nearly dead that a new growth of wood appeared from the centre, the old limbs dying. The fruit was of good quality and there was an unusually small percentage of culls. In fact, I think I had the best lot of peaches, considering color and quality, that was marketed about here this season. Many of the trees bearing good peaches had been severely damaged by the scale. I think there was scale on every tree.

"In my letter of April 8th I gave detailed cost, but I would estimate the cost of spraying an average-sized, bearing peach tree at about four cents. The spraying was not perfectly done, as my pump came late and I had to rush the work on every favorable day. Considering what they have been through, the present condition of the trees is good and promising.

"In general, I should say that spraying reduces the set of fruit and favors its development, not only by reduction of the quantity, but by the cleaning of the tree of scale and other insects and fungus growths.

"One farmer near here sprayed several thousand trees with oil undiluted. His crop was very light, but the crop has averaged light even in unsprayed orchards. The oil may not be responsible, but it is my impression that it does diminish the yield in direct proportion to the amount of oil used. The pump worked beautifully, without a catch or a hitch throughout."

The last sentence is of especial interest in view of the complaints received from other sources.

Nothing will be gained by multiplying instances, and I yet believe, after another year of observation, that there is nothing to equal crude oil for cleaning badly-infested trees. Its penetrating power is unequaled, and it is strong where the lime, salt and sulphur wash is weak; but its weakness lies in the element of danger which is absent in the less penetrating mixture.

The question of effect on trees treated more than once can now be answered to the purport that bad results do not necessarily ensue. I have watched pear and apple orchards in which trees have been treated every year since 1898, and they are certainly no worse than trees untreated, while they are much more nearly free from scale.

Concerning a peach orchard, I have word as follows: "My orchard nearest the house has now been sprayed four times with oil. Once with it undiluted on sixty-five of the worst trees and an emulsion on the balance, of about four hundred trees; once with 15 per cent. and twice with 25 per cent. Gould's Kerowater was used. It averaged one and one-half baskets per tree the two years past and promises fair to do as much this season. You may remember that this orchard was bought in 1895 and the scale was given us free of charge."

In some localities, where peach trees were sprayed with oil, there was a tendency to charge the material with killing the ends of twigs, which was very noticeable in some cases. But this same dying of tips was equally bad in orchards that had not been sprayed at all; hence some other cause must be held responsible, and the sleet storm in February is at least as likely as anything to be that cause.

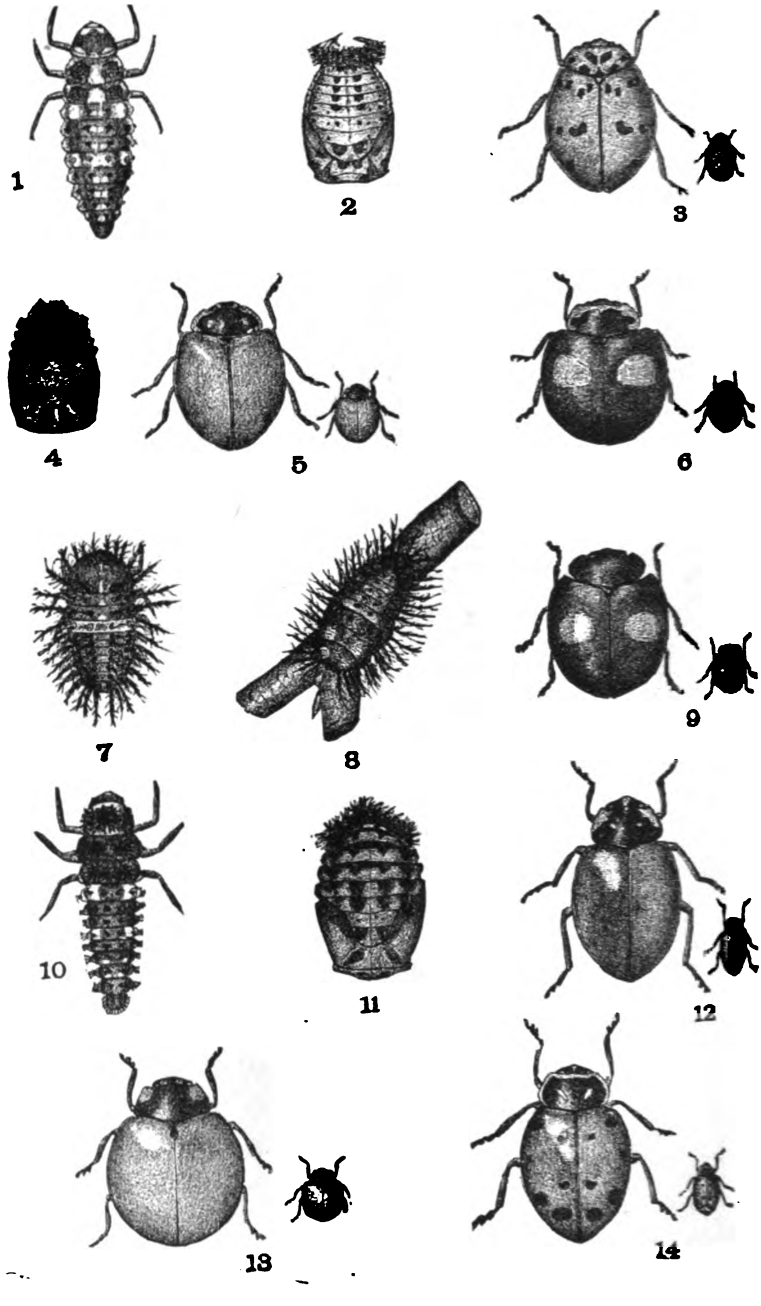

Fig. 11.

Some common lady-bird beetles: 1. 2. 3, larva, pupa and adult of *Cycloneda abdominalis*; 4, 5, pupa and adult of *C. sanguinea*; 6, adult *C. oculata*; 7, 8, 9, larva, pupa and adult of *Chilocorus cacti*, which resembles both *C. bivulnerus* and *C. similis* in all stages; 10, 11, 12, larva, pupa and adult of *Hippodamia ambigua*; 13, *Coccinella californica*; 14, *Coccinella convergens*: small beetle figures indicate natural size. From the Div. Ent., U. S. Dept. Agl.

THE CHINESE LADY-BIRD,

Chilocorus similis.

The Coleopterous insects belonging to the family Coccinellidæ, or, to put it otherwise, the beetles commonly known as "lady-birds" or "lady-bugs" are generally recognized as beneficial to the farmer, because of their habit of feeding on plant lice and scale insects. This predatory habit is not without exception, because we have in New Jersey one species that feeds, in both the larval and adult stages, upon the foliage of cucurbit vines. Other species occasionally feed on pollen, and not a few tend to vary their diet by lapping up sweet excretions from plant surfaces. Most of the species are rather small in size and some of them are very minute, not exceeding in diameter the head of an ordinary pin. On page Figure 11 is given a series of illustrations showing some of the more common types.

Two rather easily known series occur; species which are of some shade of red or yellow and are spotted with black, and species which are black, with yellow or red spots or without any markings at all. In a general way the beetles belonging to the first series are the larger, are more oval in outline and feed upon plant lice. The insects belonging to the second series are smaller, rounder in outline, almost hemispherical in some cases, and, generally, they prefer scale insects as food. To this latter series belong the species of *Rhizobius,* which were introduced from Australia into California to check or destroy the black scale. In New Jersey, though we have a number of species of scale feeders, there are only two that are at all numerous—the species known as the "twice-stabbed" lady-bird (*Chilocorus bivulnerus*) and the very small Pentila, which is hardly larger than the pernicious scale itself.

The "twice-stabbed" lady-bird is shining black, almost hemispherical, about three-sixteenths of an inch long and with a blood-red spot on each wing cover. Figures 7, 8 and 9, on plate Figure 11, represent this species in all its stages well enough to enable it to be recognized, since we have nothing else that is similar to it in the State. With us this insect has two broods, never becomes very plentiful and lives through the winter in the adult stage.

When, in 1896, I traveled through the scale-infested regions of California, I found in the southern section that this very species, the "twice-stabbed" lady-bird, was the most important agent in keeping

the pernicious scale in check. It occurred everywhere in swarms, and larvæ as well as adults were active in feeding on the dormant scales. I found, also, that instead of two broods, as in New Jersey, the insect had at least five or six, and instead of lying dormant for six months or more, it was almost continuously active throughout the year. The difference in climatic conditions, therefore, enabled the insect to do in California what it could not do in New Jersey, and this point I endeavored to bring out in my Report for 1896.

As Japan was at that time supposed to be the home of the pernicious scale, I made an effort to obtain scale-feeding lady-birds from that country, but did not succeed until the spring of 1898 in securing live specimens. On pages 446 and 447 of my Report for that year some details are given of this importation, but it is enough to say here that nineteen living examples of *Chilocorus similis* were liberated on scale-infested trees in a Riverton orchard, May 24th, 1898. Nothing was seen of these insects later and it may be assumed that they perished.

During the season of 1901, Mr. C. L. Marlatt, first assistant in the Division of Entomology of the United States Department of Agriculture, traveled rather extensively in China and Japan, carrying on the while his studies on scale insects and their habits. Among others he found the pernicious or San Jose scale in both China and Japan. From evidence satisfactory to him he determined that Japan was not the native home of the insect, but that it had been introduced into that country from the United States. He also determined that Northern China was the real home of the pernicious scale and that its natural check was this very *Chilocorus similis.*

Specimens were collected and sent to Washington, where they were looked after, and some safely carried through the winter. Mr. Marlatt's account of this species and of his experiments has not yet been published, but he was good enough to inform me that up to the middle of July, 1902, there had been three generations. "One cage in which two individuals were placed early in May, supposedly a male and a female, as they were in coitu, is now thickly stocked with them, often seven pupæ clustered under a single pear leaf, and no exaggeration to describe the cage as having hundreds of specimens."

At the Pittsburg meeting of the Association of Economic Entomologists, in late June, Mr. Marlatt was good enough to promise to send me some specimens, and this promise he repeated under date of July

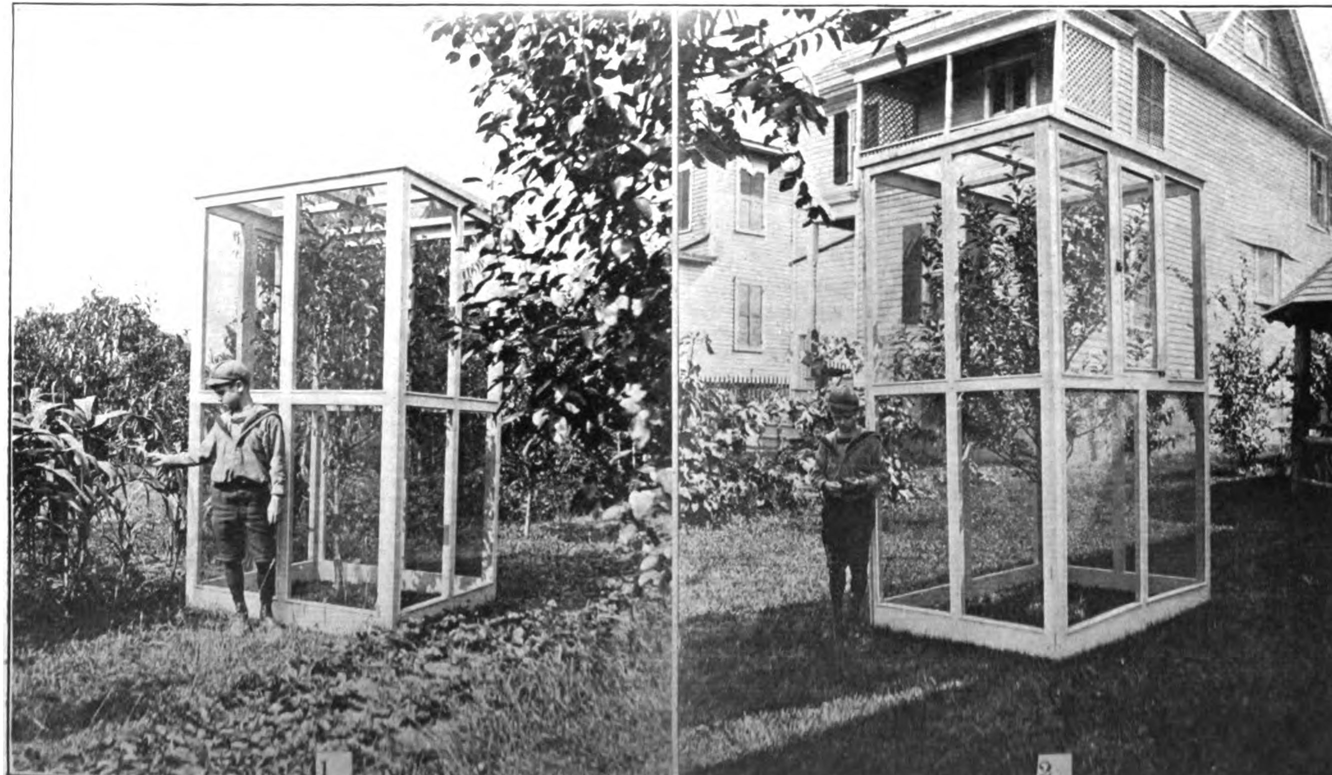

Fig. 12.

1, Cage covering tree No. [illegible] in the experiment orchard. 2, Cage covering tree No. [illegible], same place. From original photographs.

8th, sending me at the same time a photograph of the cage used by him.

An inspection of the Experiment Orchard showed that trees 32 and 36 were the smallest badly-infested trees, and these were selected for covering. No. 32 is a Lawrence pear, and it was found very full of scale, ranging from crawling larvæ to breeding females. All parts of the tree were infested and even the leaves were beginning to be covered. Tree 36 is an apple of unknown variety, and it also was then swarming with larvæ of the second brood. The cages were received July 21st and were set in place on the 22d. That covering tree No. 32 is 4 x 4 x 7 feet, and is shown at Figure 12, 1. That covering tree No. 36 is 4 x 5 x 8 feet, and is shown at Figure 12, 2. The beetles, twenty in number, were received on the morning of the 23d and were at once placed on the covered trees. They were active and were equally divided between the two cages. No attempt could be made to determine the sex of the individuals.

The trees were kept under continual observation, and some of the beetles could be readily seen at any time, usually on the trunk or larger branches. Numerous white points where scales had been torn off could be also seen, but always there were also plenty of young out toward the tips of the shoots.

Up to August 12th no traces of larvæ were seen, but it was, of course, possible to overlook them among the foliage or on the badly-infested inner branches. Mr. Marlatt says the eggs of this beetle are laid singly, beneath the scales, hence they could not be seen on such examinations as I could make. Becoming uneasy lest all the specimens should be of one sex, I wrote again, asking for larvæ rather than beetles, and on August 23d I received from Mr. F. H. Chittenden, acting for Mr. Marlatt, twenty-four larvæ, varying in size, all of which were placed on tree 36 as the larger and more scaly individual.

It has not been said that this Chinese lady-bird is so much like our own twice-stabbed species that it is not possible to tell the difference between the two on a casual examination. After some account of this species had been published in the agricultural papers, I received several letters from growers, claiming that specimens fully answering the descriptions had already appeared on their trees. The actual differences between the adults are apparent, to even the Entomologist, only after close examination, but the differences in the early stages are quite apparent. While the larva of the native form is

blackish, with a rather obvious whitish band before the middle, the Chinese larva is flesh colored. And while, as already stated, the Chinese beetle lays its eggs under a scale, the native species lays its ova openly, on the bark or leaves. Thus we have two different, if closely allied, species.

September 9th saw several pupæ and one adult just out of the pupal skin on tree No. 32, and as no larvæ had been placed on this tree, it follows that there must have been some breeding. But it was very slight indeed, and on October 22d, when I examined the tree carefully, found only a few beetles.

On tree 36 I found, September 9th, several pupæ and full-grown larvæ, but these might easily have been, and probably were, from the Washington sending.

October 2d made another careful inspection and found the beetles quite obvious. There were also a large number of pupæ, a few larvæ and some recently-developed imagoes. There had been some breeding, no doubt. October 22d noted a number of the beetles and a number of pupæ, but no larvæ.

It is obvious that on both trees the insects have bred to some small extent. The trees are yet sufficiently scaly to feed all the beetles that are on them, and, under the circumstances, it is deemed wise to allow the covers to remain and to keep the beetles confined through the winter under ordinary outdoor conditions.

a

b

Fig. 13.

***a*, A Steam Boiling Plant for the lime salt and sulphur wash, in Canada: *b*, a Sprayed Canadian Orchard. From photographs made by Mr. Geo. E. Fisher.**

REPORT ON THE MOSQUITO INVESTIGATIONS.

REPORT ON THE MOSQUITO INVESTIGATIONS.

JOHN B. SMITH, SC.D.

By an act of the Legislature of New Jersey, passed at its session during the early months of 1902, and duly approved by the Governor, the Agricultural Experiment Station was "empowered and directed to investigate and report upon the mosquitoes occurring within the State; their habits, life history, breeding places, relation to malarial and other diseases, the injury caused by them to the agricultural, sanitary and other interests of the State, their natural enemies, and the best methods of lessening, controlling or otherwise diminishing the numbers, injury or detrimental effect upon the agricultural, sanitary and other interests of the State."

The law was not passed until late in the session, and no money was provided to carry it into effect. It was due entirely to the appreciation by Governor Murphy of the importance of the investigation that any work at all was possible, and he promptly placed at the disposal of the Station the sum of $1,000 from an emergency fund within his control.

The writer of this report was appointed to make such studies as were possible under the circumstances, and work was begun late in May, after the mosquito season was already well started. Fortunately, the work done by me during 1900, which was detailed in the Report of the Agricultural College Experiment Station, served as an introduction to this investigation, and enabled me to secure results that would have been otherwise impossible.

It will be realized that a problem so extensive in scope as is outlined in the act above referred to cannot be solved in any one year, with so limited an amount of money at hand. All that could be done was to start the work and to ascertain as fully as possible the direction in which future investigations would be likely to be most fruitful.

This, then, must be considered as a report of progress merely and as a narrative of what investigations were started.

It was realized that when the exact role of certain species of mosquitoes, in carrying or transmitting the disease organisms causing malarial fevers, was once thoroughly understood, the matter of dealing with such mosquitoes would be merely an extension of the sanitary work already in charge of boards of health, local and general; hence, I secured the services of Dr. Herbert P. Johnson, who had paid much attention to these studies, had served as an assistant in the Harvard Medical School and had also worked with Dr. Theobald Smith in the laboratory of the Massachusetts State Board of Health. A conference was had with Dr. Smith early in June, and Dr. Johnson began his work in New Jersey soon after July 1st, in quarters placed at his disposal by the Harrison Board of Health. Grateful acknowledgment is due to this board and to its members and their inspector for this and other courtesies extended.

Dr. Johnson continued his work until September 20th, and his account of what was accomplished forms a supplement to this report. It should be added that Dr. Johnson turned over to me on September 19th a very lively lot of hungry *Anopheles* mosquitoes, and that on the 24th of that month they were treated to a meal of blood from a patient suffering from malaria. The specimens were later examined by Dr. W. N. Berkeley, of New York City, but no definite results were obtained. We have no positive evidence to prove that our most common species of *Anopheles punctipennis* can act as an intermediate host for the malarial disease parasite; but against the other, *A. maculipennis,* the case is definitely proven. On this point and on the breeding habits of *Anopheles,* Dr. Johnson's report should be consulted.

The subject of the natural enemies of mosquitoes is of much greater importance than is generally realized. They need water in which to pass their early stages, and almost any kind will answer for some species. That large bodies of water do not necessarily mean large numbers of mosquitoes is a matter of common experience, and the natural question is, why is that the case? To answer this it becomes necessary to study the fauna of those places where the insects breed and larvæ are found, in comparison with those places in which they do not breed and where no larvæ are found. It is desirable to know, also, whether any of the smaller birds make use of the adults as food to any considerable extent.

This branch of the work was placed in general charge of Mr. illiam P. Seal, of Delair, N. J., formerly in the service of the aited States Fish Commission and thoroughly acquainted with the esh-water fauna in this section of our State. His observations are served for the present and will be used in the final report, to indite the lines upon which such work must be conducted. It was ped that it might be possible to secure the co-operation of the Fish d Game Commission of the State in the study of some of the other rtebrate enemies of the mosquito, but up to this time the effort s not been successful.

A simple observation made during midsummer will illustrate the portance of the subject. Two water barrels, close to a farm-house, came very full of wrigglers. The boy of the house, who had been newhat interested in the subject, caught a small roach in a pond arby and placed it in one of the barrels. In a remarkably short ne, not a wriggler was left, and when the fish was transferred to other barrel that also was cleared. Cisterns, therefore, or water rrels need only a few examples of these little fish, that occur all er our State, to make them perfectly safe. As there would be no tural nemies, even a single little fish would last out an entire season.

Another practical illustration comes in a nursery where water plants raised in large numbers in ponds, tubs, basins and receptacles of kinds, indoors and out. Conditions for mosquitoes would seem to ideal; but in every tub, every pond and every pool little fish have en placed, and in the course of a somewhat hasty inspection I found trace of larvæ. I was assured that there were none, and learned mediately thereafter that the tank connected with the copying press, the office, having been neglected for a week, had been found swarm- with them.

Mr. Seal, besides carrying on the line of work already referred to, lected carefully, from all sorts of places, mosquito larvæ, which were t me alive, and thus I obtained several forms of great interest; one them never before bred.

Mr. J. Turner Brakeley, of Lahaway, was a voluntary assistant, to om I owe a full line of specimens from the pines, accompanied by l records of careful observations. Some of these observations have n already used, some are referred to in the body of this report and ne will form part of the life history of the species that I hope to sent in a final report. Two species never before bred by any one

were obtained at Mr. Brakeley's place in the pines, and other species not before bred by me were also received. Altogether, Mr. Brakeley's contributions toward a knowledge of the life history and habits of the New Jersey mosquitoes are of the highest value.

Mr. E. L. Dickerson, of Newark, New Jersey, was with me during the year, mainly as assistant in the work of the State Entomologist, but also engaged as an aid in the mosquito investigation. He made many interesting collections, and as an example of the possibilities of municipal work I had him make a survey of the city of New Brunswick, locating on a map all the places where he found mosquito breeding places, together with suggestions as to how each place should be dealt with.

Beginning June 20th, Mr. Otto Buchholz, of Elizabeth, New Jersey, began a series of collections, near his residence on Adams avenue, to determine the species of mosquitoes that occurred during the summer. Collections were made both indoors and out, at about five-day intervals, and on a subsequent page will be found a list of his captures, which is interesting and suggestive.

Personally, I have been in almost every part of the State, have consulted with improvement societies, or their representatives, have suggested lines of work for local bodies and have made inspections, where it was necessary, to arouse interest and give information. But my principal line of work has been in connection with the salt marsh or shore mosquito, which, whatever may be the case elsewhere, is likely to make local work within its range unsatisfactory and only partially effective. Its range this year has not been exactly the same as it was last year. In 1901 it was the dominant species at New Brunswick for weeks at a time, and my garden was so full of specimens that when evening approached, it was an unpleasant place to remain in. In 1902 there was not a day when this species was troublesome; it was never the dominant species and very few specimens were in the garden.

A record of what I have learned about this species during the season is presented on a subsequent page of this report. One of the collateral results of my own work was the engagement of Mr. H. H. Brehme, of Newark, to make a survey of the Newark meadows, and during the six weeks many important facts were learned that will have a bearing upon the practical work of dealing with this species. At Elizabeth an organization had been formed to fight the local mosquitoes; [illegible]

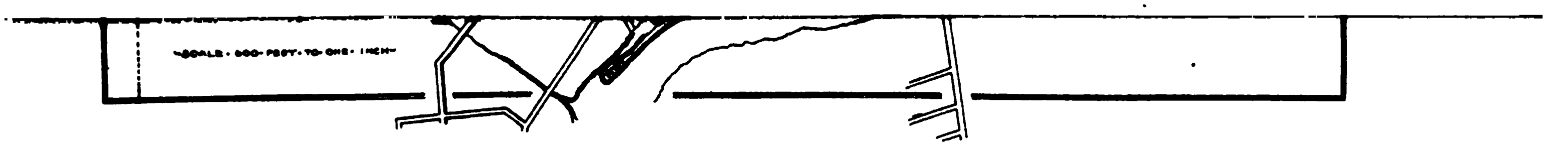

Fig. 1.

Map of the City of New Brunswick showing where mosquitoes breed. The red areas are the breeding places.

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. Wm. F. Robinson, who was in charge, recognized so well the im-rtance of the salt-marsh form in the problem, that he secured the propriation of a sum sufficient to keep Mr. Brehme in the field two eks longer than would have been otherwise possible.

The results of Mr. Brehme's work are also presented herewith.

Altogether, something over twenty species were bred, and, so far as lections go, there are only three species of mosquitoes taken in New rsey whose larvæ are unknown to me.

A discussion of the results obtained from observations on other ecies than *Culex sollicitans* must go over until a future date and for inal report.

Observations on the Salt Marsh Mosquito.

The observations made on this species during the summer of 1901 t no doubt in my mind as to its importance in the general problem. th this insect removed, the seashore would be practically free from squitoes; and not the shore only—the pines for miles back would freed, and the shore area would be increased in value by many llions of dollars. It seemed a stupendous task and beyond all sonable hope of attainment; but the estimates were formed on iefs rather than facts, and my task was to discover the facts.

First of all, the winter home of this marsh species was unknown, l while it was assumed that hibernation was in the adult stage, one had actually found the species. So, on April 4th, I sent Mr. :kerson to Anglesea, with instructions to hunt mosquitoes in all ts of likely and unlikely places, but to find the adult if it existed. glesea was selected because I knew the place thoroughly, knew ny of the people, knew that there had been many specimens during summer of 1901, and knew that I could get access to cellars and buildings.

During the afternoon cellars were examined and storerooms under b-house, etc. The results were twenty-six *Anopheles maculipennis* l four *Culex pungens*. The bathing pavilion and the area underneath ielded nothing. Next day a vacant house netted thirty-five *Anopheles culipennis* and nothing else. On the bay side of the island wrig-rs were found in salt pools at the edge of the meadow, under shelter a high bank covered by trees and shrubs—a warm corner, sheltered m cold winds. The larvæ were in various stages of development, some of them were very small, as though recently hatched.

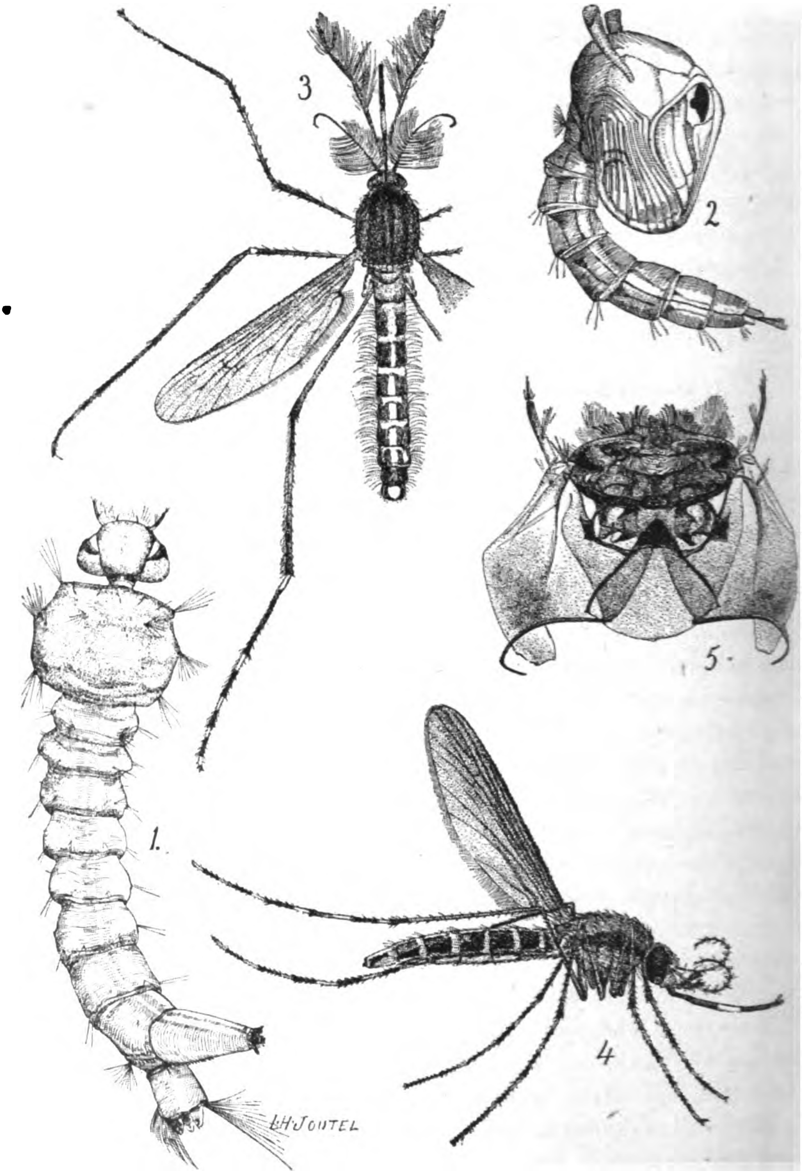

Fig. 2.

The Salt Marsh Mosquito, *Culex sollicitans*: 1, larva; 2, pupa; 3, adult male from above; 4, adult female from side showing the banded beak and legs; 5, head of larva; all greatly enlarged. From an original drawing by L. H. Joutel.

The results of the trip were not satisfactory, and on the 11th Mr. Dickerson again spent a day at Anglesea, this time hunting in the woods, in hollow trees, under bark, under overhanging banks, logs and natural shelter of every description. Attempts were made to start adults among the tall grass and from other conceivable places of concealment along and near the edge of the meadows. All without results, since not a specimen of *sollicitans* could be found. But a lot of larvæ was brought up, from which *cantans* and *sollicitans* hatched, in almost equal numbers, between April 14th and 21st.

The pools from which these larvæ were taken fill up only in very high or storm tides, and evaporate and fill up as it rains or shines, the water ever becoming less salty until another tide comes over it.

April 19th and 20th I spent at Anglesea myself, and not far from the hotel found a pool just beginning to dry up and already swarming with larvæ; another, not far off, was in the same condition, but here the larvæ were very minute—not over a day or two old. Searched closely for egg-boats or traces of them and for adults that might have been parents to the recent larvæ, but found nothing. Tramped over a large marsh area, finding no larvæ in ditches or salt ponds. In one area of very wet meadow, with little holes, two-thirds of an inch in diameter and as deep, I tried dipping out one of the holes, and, to my surprise, found larvæ. Every little hole over this entire area had a few wrigglers as inhabitants. One fact forced itself upon me: no deep pools, even if completely shut off from the tide, had any larvæ of any size. Not until the pools began to dry up did the larvæ make their appearance. Those that were nearest dry had the largest wrigglers; those that were but recently cut off and only a little dried out had the babies.

The apparent suggestion was that it was a matter of temperature, and that eggs would not hatch until a certain degree of warmth existed; but that, again, meant that the eggs were under water, ready to be hatched, and must have been there all winter. This was contrary to all the books, and could not be too hastily accepted; but, at all events, the matter of temperature could be approximately determined. The only thermometer available was a cheap affair, in the ordinary tin casing, and it may have been off to some extent; but the results have a comparative value at any rate. The temperature of the air at 9 A. M. was 48°; temperature of sea water, 50°; temperature of the salt pools from which the larvæ were taken was 52°;

temperature of the old salt pools where the larvæ were taken on the 11th and were now most advanced, 55°.

Fresh water temperatures taken during the morning in ditches and wood pools was 52.5° to 53.5°. In one case, in a rather large swamp area, it dropped to 50°. Not a larva was found in any fresh water body that morning. In the afternoon waded into a flooded meadow area in front of the railroad station and found larvæ everywhere: also one pupa. This meadow slopes naturally toward the seashore, and in cutting and filling the streets a large tract sloping to one corner was left without outlet.

It was entirely dry in the fall of 1901 and did not fill until winter was well advanced. Then it became all flooded, served as a skating rink during the winter and as a boating pond earlier in the spring. It was never tide-filled, and the water, when I tasted it, seemed entirely fresh. Drying up had begun, and over a large area there was not over an inch of water.

I made a very close search for adults near and under the bathing pavilion, but found none.

From the pupa brought home by me, *Culex sollicitans* emerged, and April 25th sent Mr. Dickerson down to make thorough collections from this body of water. He brought back a large lot of larvæ and pupæ, and from all of these *sollicitans* was bred. Mr. Dickerson reported the meadow as drying up fast and that, as the water receded, the larvæ became more crowded and seemed comparatively more numerous. All the salt-water pools were now filled with larvæ, and five bottles of wrigglers were brought back from as many different areas. *Sollicitans* only was bred from all the bottles, and it was certainly established that salt water was not essential to its development. Absolutely fresh water did just as well. Moreover, as this area was dry for some time after the mosquitoes had disappeared for the season, and none of the pests having been found before the larvæ made their appearance, it seemed almost certain that the eggs must have been there before the water covered the ground; in other words, the eggs are laid on dry sod land and hatch only when covered by water of a temperature some degrees above freezing.

Breeding being now fairly started, matters were left until well along in June, because of a press of other duties. June 14th, spent another day at Anglesea and, in company with Captain Hankins, investigated a portion of the salt meadow area lying between five-mile beach and the mainland. To my very great surprise, found that

this area is really very well drained, very flat and swarming with fiddler crabs. Salt ponds in plenty; some deep, some shallow; but fish in all of them and not a mosquito larva. Captain Hankins tells me that much of the salt marsh area is exactly like this, and, during the four hours or more that we rowed through creeks and tramped over suspicious sections, not a wriggler was seen. Many miles of this meadow land will need absolutely no treatment whatever, and breeds no mosquitoes. From hour to hour the conviction grew that, were the broad meadow itself the only area to be treated, the matter would be very simple.

On returning to the hotel from the pier, noted a small duck pond filled with larvæ, and on both sides of the road tide pools, now drying up and absolutely swarming with larvæ and pupæ. Males had just begun to issue and they rose in clouds from the grass at the edge of the pools, but, of course, could not bite. No females seemed to have issued as yet. In this series of pools, the largest not over fifteen square feet in area, hundreds of thousands of larvæ were developing; more than were on the entire square miles of marsh area I had covered that day. A few quarts of kerosene would have killed the whole brood in a few hours; a few loads of sand from the adjoining sand hills would have permanently cured the whole matter. I called the attention of the mayor of the town and of the proprietor of the hotel, not over 100 yards way, to this condition of affairs. The former expressed great astonishment, the latter great disgust; neither of them did anything else, and that series of pools continued to develop mosquitoes throughout the summer.

On the evening of the 14th met with a number of persons interested, in Cape May, at the Marine Villa, by invitation of Mr. John M. Rogers, who has urged measures for mosquito destruction or control for years past. Mr. Frank M. Jones, of Wilmington, Delaware, was also present as the guest of Mr. Rogers, and informed me that he had made a preliminary survey of the territory, finding very little that could be considered dangerous, and a very few larvæ.

A very superficial examination of the surroundings was made on the 15th, and from what appeared, Cape May City can very easily rid herself of all local breeding places with little trouble and expense. There is a rather extensive swamp between Cape May City and Cape May Point, near the light-house; but it was very dry at that time and very difficult to say what this place would do in a wet season or when overflowed by a tide. The region toward Sewell's Point is said

to be a great mosquito-breeding country, but I did not get to this place at all during the season, though I intended to do so.

June 20th, saw Mr. A. V. Dayton, then Superintendent of the West Jersey and Seashore railroad, at Ventnor, and looked over with him some of the ground between Ventnor and Longport, where mosquitoes become very numerous and from whence they sometimes get into Atlantic City. I was able to point out to Mr. Dayton how, sometimes, "improvements" created breeding places by leaving low areas without outlets through street or road fillings or railroad dams. One especially bad area had been made so by filling in a street which cut off the access of tide-water that had previously reached it. Mr. Dayton promised co-operation by the railroad company in the general aims of the work, and it was at his suggestion that Special Bulletin T was prepared. Nearly or quite 100 copies of this Bulletin were sent to division superintendents for distribution among those in charge of the right of way, with instructions to abolish mosquito breeding places, so far as possible, whenever such were found.

The line of work now being done at and near Atlantic City is fast doing away with mosquito-breeding places at the edge of the marsh, but some bad areas are left and others are created through ignorance of the conditions which favor the development of these insects. It is believed that a careful survey of this area, pointing out the conditions that favor the breeding and the dangerous area, will result in the rapid improvement of those conditions and the removal of the dangerous area.

Early in July, having decided, from the evidence obtainable, that *C. sollicitans* has altogether different egg-laying habits from those described for *C. pungens*, I planned a campaign at Anglesea that should result in answers to the following questions: 1. Where do these mosquitoes lay their eggs? 2. How long does it take them to get ready to lay? 3. How many may one individual place? 4. Is it necessary for the female to feed before she is able to oviposit?

A series of seven tubs was sent to Anglesea from New Brunswick; Mr. Dickerson went down July 7th and I followed later in the day. The tub experiments were assigned to Mr. Dickerson, while I conducted a series of marsh explorations.

Mr. Dickerson's record is essentially as follows, up to the time that I left him in charge: Placed the seven tubs in the backyard of the Keystone Rod and Gun Club house so that only a few inches projected above the surface. In one tub put a few inches of salt water

only and in a second some sod from the salt marsh, covered by two or three inches of salt water. Mosquitoes were very abundant here, and the tubs were left uncovered, to see whether any mosquitoes would oviposit in them. As breeding pools were rare at this time, it was hoped that these tubs would be very attractive. In a third tub sod was placed, with just water enough to keep it moist, and in all the others the bottom was covered with sod, and salt water, to cover well, was added.

Several jars of larvæ were collected in the afternoon, and in the evening a few mosquitoes were collected and placed in a jar, with a little water and some grass, to see if eggs could be obtained in that way.

July 9th, placed a jar of larvæ in each of the covered tubs containing water-covered sod, that the adults, when they issued, might have opportunity for oviposition if they so desired. In the afternoon experimented with Chloro-naptholeum on *sollicitans* larvæ. Four quart jars were more than half filled with decidedly brackish water and all were well stocked with larvæ. With a medicine dropper put in two, four, six and eight drops, respectively. An hour later nearly everything was dead in the jars containing six and eight drops; in the jar with four drops many were dead, and in that with two drops a few were gone. In this diluted sea water the Chloro-naptholeum forms a film on the surface, which drives the larvæ down when they attempt to pierce it. A few young fish and water boatmen in one of the jars were also affected. Yet an hour later everything was dead in all jars, except for one or two larvæ and some other creatures in the jar containing two drops. In the evening mosquitoes were collected in a jar and placed in the tub containing only moistened sod, that they might oviposit on it if they would.

July 10th, secured additional material for experiment, located several new breeding pools and sprayed two pools with Phinotas oil, very liberally applied. Two jars with pupæ were prepared, to test the comparative value of Chloro-naptholeum and Phinotas oil, and five drops of each were used. The Phinotas oil also produced a surface film, but did not make the water milky. Next morning the pupæ in both the jars seemed very little affected, and that was the case in the sprayed pools, from which adults were now coming in great numbers. Next day the pools had dried completely and the breeding pools were everywhere disappearing, layers of dead larvæ and pupæ being left on the surface mud in many cases. One matter was very

definitely proved at this time—neither larvæ nor pupæ bury themselves in the mud as the water evaporates. When the water disappears they simply die, no matter what stage they may be in. To determine whether eggs had been laid in the water some of the surface mud from the recently-dry pools was obtained, part of it placed in jars and covered with water, and part was taken to New Brunswick and washed out in the laboratory; no eggs being found nor larvæ secured in either case.

On the 12th I left Mr. Dickerson in charge, and he carried on the experiment by keeping up the mosquito supply in the tubs, placing food in some and leaving others bare and whatever else was necessary.

Mosquitoes were also captured and confined in jars, with soil, with water, with tufts of grass and without any addition whatever. In almost all cases eggs were obtained without any trouble, and appeared on the leaves, on the ground, on the grass blades below the surface of the water and even on the bare glass. The insects were simply ready to lay and placed the eggs anywhere; usually they were black but white ones also were laid in some places.

These eggs were left in the jars, some covered with fresh and some with salt water, some jars kept indoors and some outdoors under natural conditions; but in no case did they hatch while under observation—a period of four or five days.

July 15th, Mr. Dickerson sent me up some eggs obtained in this way, and also a few adults, of which five were dissected, with the following results:

No. 1.	Black eggs	46	......
	Gray eggs	17	......
	White eggs	101	164
No. 2.	White eggs only,	......	117
No. 3.	Black and gray eggs only	......	148
No. 4.	White eggs only	......	135
No. 5.	Black and gray eggs	47	......
	White eggs	35	82

As to No. 5, it was quite possible that it had already deposited part of its eggs. It is noteworthy, in view of what appeared later in the season, that at this time there was no difficulty in getting any desired number of gravid females.

July 16th, all breeding pools were practically gone; in the grass was a lot of old adults and a vast swarm of recently-developed forms, male and female; on the evening, with a west wind, the hotel porch

and the beach to the water's edge became overrun with them. As the same wind continued next day, matters became much worse, until the whole shore area became filled with specimens.

July 18th, I reached Anglesea again myself, and on the 19th all the tubs were overhauled and Mr. Dickerson's observations collated.

The uncovered tub, No. 1, was kept with from one to three inches of sea water during the two weeks that it remained in the ground. No larvæ developed at any time and the water remained clean. It was always cooler than the water in the surrounding pools, but was always warm enough for mosquito development. On the 19th found a little group of ten or twelve eggs at one side of the tub, near the surface of the water, and they seemed to be of this species. Nothing was in the water itself. In view of the fact that mosquitoes were very abundant in this place and that they had had two weeks in which to oviposit, it would seem to be a fair conclusion that eggs are not laid in permanent, open bodies of water. This is borne out by the fact that I have never found larvæ in pools with clean edges and without vegetation. There are many such ponds and pools on the salt meadows and they may in general be accounted safe. So, on sand flats and mud flats, I have frequently seen large areas of shallow water, in which no trace of larvæ was found. The eggs found in this tub were placed in a cup of water, but were afterward mingled with others obtained under natural conditions, so I cannot tell whether these hatched. The eggs sent to me at New Brunswick had tended to split and break after three or four days, as if the contents had fermented and burst their envelope.

The second exposed tub was bottomed by mud-covered sod, flowed by an inch or more of salt water, and this was intended to represent a grassy pool. The water evaporated pretty close to the surface at times, but it was never allowed to go quite dry. No eggs were noted in this tub at any time, and when the whole matter was dumped out and examined on the 19th, neither larvæ nor eggs were to be seen. No natural breeding pools were near by at the time, and if that sort of locality is favored, this would have been an ideal place. Nevertheless, after two weeks, not a wriggler was found in the water, every particle of which was closely examined and not an egg was found on the grass, almost every blade of which was examined with a lens. It would seem to follow from this, added to observations made at the edge of the marshes, that the insects will not oviposit in any water-covered areas.

Tub No. 3 was covered with mosquito netting and had a bottom layer of sod, which was kept moist. A jar of mosquitoes was collected July 8th and turned loose under the netting. It was noted at the time that all were females and that many of them had the abdomen fully distended as if by ova. Adults with fully-developed ova were collected a day or two later from the same area, hence this point may be considered as beyond reasonable doubt. July 14th, the mosquitoes were dead, and salt water was added until the sod was covered. This tub was intended to imitate a moist marsh area, in which mosquitoes had an opportunity to oviposit, and when the water was added the eggs, if any were laid, should have an opportunity to develop. On the 19th no larvæ were found in the water and no eggs were found on the sod. I cannot quite explain this failure to find eggs at any rate, unless they went to pieces, like those in the jars. In view of what was later found, the indications would seem to be that the eggs need a certain period of drouth, during which development takes place, and that if they are water covered too soon after they are laid, they burst.

Tubs 4, 5, 6 and 7 were all covered with mosquito netting, all had sod bottoms and all had water enough to cover the surface. Live mosquitoes were placed in each tub, and also a jar with numerous full-grown larvæ and pupæ. No definite information was gained from these tubs, all of which were bare of either eggs or larvæ when examined.

All the indications pointed now to eggs laid dry in mud or sod and, first of all, samples were secured from the bottom of a pool that dried out a week previously, after having matured a large lot of mosquitoes. The soil was sandy, with a crust of organic matter about one-sixteenth inch thick, which tended to become dry and leathery. No eggs were found in this. From another pool other samples were washed, and dead larvæ and pupæ were floated out, but no eggs. Then sent Mr. Dickerson to cut out a section of sod from an area where we had found mosquitoes abundant on the 8th and 9th. This was near a pool that dried up completely on the 11th, but the area from which the sod came was already well above the water line on the 8th, and had certainly been dry at least several days before. The section brought in was about four inches square, was moist, the surface mud covered, and, when I examined the edges with a lens, I at once found the eggs imbedded in it. The mud was about one-fourth inch thick, the grass was very dense, and below the mud was a tangled mass of root fibres, like green turf. A small portion of this

surface was washed out and eggs were found in it in such numbers that there could be no doubt that this was their natural home. When they were deposited there, could not be even approximately determined. Gravid females were there on the 8th, but they might have been there long before, and what eggs were obtained from those taken on the 9th failed to develop larvæ.

Having determined the presence of the eggs in some number, I cut the grass close to the surface and washed the mud into a granite basin until the tops of the grass roots were washed clean. The basin, half filled with fresh water, was left until the mud settled a little, to make sure the eggs did not float, and was then placed on a table in the club-house at 9 P. M.

I should have said previously that, by the courtesy of the members of the Keystone Rod and Gun Club, of Philadelphia, these experiments and investigations were carried on at their club-house and in the grounds surrounding them. I take this opportunity to acknowledge the courtesy and to express my gratitude and appreciation for the assistance rendered.

Next morning, at 8 A. M., the granite basin was swarming with wrigglers. We made no serious effort to count them, but there were 300 certainly, and perhaps 500.

Two sods were cut on the 21st, from the same general area where the eggs had been found, and these were carried to the laboratory, where one was placed in a large dish containing an inch or so of water, that it might be always thoroughly moist or even wet, yet the water was never allowed to come so near to the mud surface that eggs could fall into it or larvæ hatched in the wet mud would be likely to reach it. The other was placed in a large, porcelain, evaporating dish, so that air could circulate all around it, and no water was added so long as it remained there. The fortunes of these sods will be followed on a later page.

On the 18th and 19th collected a large lot of mosquitoes for examination, at the hotel porch and in the grass around the old pools, and did not appreciate, until later, that I had in view the end of one brood and the beginning of another that was destined to represent the species at Anglesea for several weeks before there could be local additions to it. Gravid females were already present on the 8th, and on the 18th they occurred in the same places—worn and battered examples, low down in the grass, caught only by sweeping closely in the early evening.

On the 8th, also, we found a new brood coming out from the fast-diminishing pools, and thousands of males were seen. On the 19th no more males were found; but the fresh females swarmed in the grass and came to the hotel porches in great numbers. Not one of these females contained even a trace of ovarian development. The males were gone; it is fair to assume that they fulfilled their purpose in life before disappearing; but it is equally certain that of all the flying swarms that were ready to attack none was in position to oviposit. There was not even a trace of an enlargement of the ova in the ovarian tubes.

Of the material collected in the grass over 100 specimens were examined and the developing ova were counted. In stages of development they ranged from half to full-grown eggs; the latter from soft white to gray, translucent. In number of ova the range was from 75 to 200, with an average of about 175. It was a notable fact that in the great majority of cases obvious remnants of blood food were found in the alimentary canal, where the ovaries were well developed. So general was this that the exceptions were considered as cases where the material had been so completely absorbed or excreted as to make its recognition impossible to ordinary examination.

While Mr. Dickerson was arranging for the details of the tub experiments, I explored some of the marsh areas, with Mr. Richard Button as boatman and guide. On the 8th rowed through Beach creek to Wildwood and then across to the marshes basing the upland. Landed at several points and from the boat examined the flat lands. Tramped about a mile of marsh to the upland, diverging wherever pools could be seen. Everywhere there were fishes, large and small, fiddler crabs and other creatures, but nowhere any mosquito larvæ. Nor were any encountered until the land began to rise and we were beyond the range of the ordinary monthly high tides. When we reached that point some mosquitoes began to rise in the grass in front of us, and in a little while I began to find larvæ in the holes filled with water, where there were no fish nor crabs. As soon as we struck the real upland everything was full of mosquitoes, and I found that every little hole, every pool and every little run that came into the marsh had its wriggler fauna. The rise here is rather sudden, and the line between mosquitoes and no mosquitoes is sharply marked. The number of breeding places in this area is rather small, and there would be little difficulty in draining this so as to get rid of all these pools at the edge of the upland. The interesting and important result

of this trip is a confirmation of the conclusions reached in June—that the salt marsh area, as a whole, is not to be considered dangerous as a mosquito breeder. No salt pools free from vegetation contained any mosquito larvæ. Nowhere on the marsh, within the range of the tide, did mosquitoes occur in the grass in any number, and nowhere in any of the channels running through the marsh was there any trouble with them.

July 9th, we rowed over to Seven Mile Beach and landed on the bay-side, a little below the life-saving station. Crossed the marsh to the high, middle ridge and to the shore, noting nothing that was new. A very large pool had been left by a high tide in a sandy basin, and this was slowly evaporating; but it contained no wrigglers. This was expected, for the insects do not oviposit on bare sand.

At the life-saving station, Captain Ludlam, who was in charge, said that mosquitoes were never very numerous to the south, but came from the west and went northwardly, while the woods toward the bay-side were always full of them. Crossed this woodland, which more than justified what had been said, and beyond it found a circular, depressed area or basin 200 feet or more in diameter, with from one to three inches of water, in which grass was growing everywhere. The water was lukewarm and was actually alive with wrigglers and their pupæ. Adults, too, were swarming, and, altogether, a more ideal mosquito breeder it would be impossible to imagine. The water was salt as the sea itself, and was undoubtedly tide-water, with very little addition from springs in the woods above, which did not furnish enough to prevent its gradual drying up. The place is completely cut off from ordinary tides; sand hills, ten to fifteen feet high, surround it almost completely, and to the east they are tree-covered. Toward the west, or bay-side, is an opening in the hills, forming a bar about one foot above the general level of the basin. Over this bar the tide gets in when the whole marsh is flooded, and on such occasions very few fish seem to be carried up so high. Literally, millions of mosquitoes had hatched and would hatch from this area, and, with a southwest wind, would fill Piermont, Stone Harbor and Seven Mile Beach in general; with an easterly or southeasterly wind they would drift to Cape May Court House and other places on the peninsula. This is one of the places from which come the great clouds of specimens that fill the pines and the South Jersey region in general. A ditch through the dam closing this basin, draining it to the general salt marsh level, would cure this place at once;

and such places as this must be sought out and cured to free South Jersey from the mosquito pest.

July 10th, rowed to Shell Beach Landing, toward Cape May Court House. Explored the marsh to the upland, and found this to be the best natural gradation into upland that I had seen. The marsh is very level, and where it begins to rise above ordinary high tides, salt hay may be and is grown. From the edge of the marsh to the base of the upland few mosquitoes were found, and no larvæ were in the pools, which mostly contained fish. Along the upland some mosquitoes were encountered, and, in a deep ditch made to get material for a road, found plenty of wrigglers. Had some conversation with one of the oystermen, who tells me that the monthly high tides cover the marsh completely to the upland, except in August and early September. The last tide had occurred on the 7th or 8th of July, and this would not be equaled again until late September or October. All the pools left by this last tide contain minnows, but these would die in about a week, when the pools dried up, and then, when it rained and filled the pools once more, they would be full of wrigglers and would swarm with adults. This is practically what Mr. Seal has claimed for certain species at Delair, and it is in accord with the observations made by myself.

The three days on the marshes of this area proves very conclusively—*first,* that by far the greatest area of salt marsh land between the edge of the mainland and the edge of the islands lying parallel to the coast is not and cannot, under ordinary conditions, become dangerous from the mosquito standpoint; *second,* that wherever the little species of minnow (*Fundulus*) can maintain themselves from tide to tide no mosquitoes can or do breed; *third,* that the breeding places are at or near the edges of the upland, where pools are left which the low, summer tides do not reach; *fourth,* that the first breeding places of spring are those areas very high up, covered only by the highest winter tides, which warm up early and bring to maturity a brood from the eggs that had wintered over.

It has been recorded that on July 21st two sods were gathered on the meadows at Anglesea and brought to New Brunswick.

July 31st, cut off about two square inches of the sod that had been kept dry, washed the top layer of soil into a glass dish by means of a pipette and left it over night. August 1st, Mr. Dickerson counted 117 young larvæ. Growth was slow, perhaps because of lack of food and fresh water, and on the 11th put in a bit of salt sod, about which

all the surviving larvæ at once grouped themselves. August 12th, first pupa; August 13th, three more pupæ; August 15th, several more pupæ and one male adult—*Culex tæniorhynchus.* About a dozen adults were bred from this lot and every one was *tæniorhynchus.* In view of the fact that nothing but *sollicitans* adults occurred where these eggs were taken, this was rather startling!

August 10th, cut off about one square inch of dry sod, rubbed it up in fresh water in a glass dish, and left it there just covered. At 10 A. M. a dozen or more wrigglers were already hatched and moving about in a most lively fashion. As I was desirous only of testing the vitality of the egg, I did not carry further, but placed the larvæ in alcohol.

August 10th, cut off about two square inches of the wet sod and placed it in a dish, just covered with fresh water. At 9 A. M., fifteen minutes later, saw two eggs floating on the surface. Next morning no larvæ had developed, so the sod was cleaned out, and in the mud Mr. Dickerson found a few eggs and many egg fragments. It is obvious that the eggs were there sure enough, but that something hindered their hatching.

August 11th, cut off two square inches of wet sod and washed off the surface into a glass dish at 7:30 A. M. Four eggs floated to the surface during this operation. Next day there were more floating eggs, but no traces of larvæ.

August 12th, 8:45 A. M., Mr. Dickerson washed off a small piece of dry sod and began collecting the eggs for preservation. At 9:15 A. M., just half an hour later, he reported that larvæ were beginning to issue, and I had an opportunity to see the pure-white wriggler just out of its shell. About one-fifth of the egg lifts off and folds back, as if on a hinge, giving the little larva a chance to work out.

Placed the piece of sod that had been washed into a large dish, and in another hour had more little larvæ, which, again, were not bred.

August 25th, placed a piece of dry sod in salt water from the Newark meadows at 10:15 A. M., and at 12 M. larvæ began to hatch. Quite a fair lot of them was obtained, and pupation began September 4th. The first adults issued on the 6th, and on the 9th, when the culture was closed, I had a dozen adults—all *tæniorhynchus*—and as many larvæ and pupæ.

Other small pieces were taken from the dry sod, from time to time, and some were given away; in every instance larvæ were obtained in a short time, but none were bred to maturity.

From the wet sod similar fragments were taken, and in all cases the results were negative—*i. e.*, no larvæ hatched, though in every instance floating eggs were seen.

September 21st, placed the entire remnants of the wet sod in a large dish and covered with water. Next morning, to my surprise, a number of larvæ was observed, and on the 25th fifteen examples were transferred to a small dish containing clean water and a piece of fresh sod. This transfer became necessary, because the old sod was getting very foul and the larvæ were dying off. On the 29th the first pupa formed, and October 1st there were six more pupæ and three larvæ. October 2d, there emerged one male *tæniorhynchus*, one male *sollicitans;* October 3d, two female *tæniorhynchus;* October 4th, one male and one female *tæniorhynchus* and one female *sollicitans:* October 5th, one female *sollicitans*. In all, eight specimens, of which five were *tæniorhynchus* and three were *sollicitans*. If we have two species, their eggs were mingled in the same sod, and the larvæ were so nearly alike that no differences were noticed. The surprising thing was that any egg should survive so long a period on a soaking wet sod!

October 4th, placed the balance of the dry sod in water, to which a little sea salt had been added. This was done at 10:50 A. M., and the sod was so dry that it was necessary to weight it down to get it covered by the water. At 1:30 P. M. little wrigglers were in the water, all around the edges of the turf, and next day over 100 specimens were actually counted.

On the 8th, as the water was becoming foul from the old sod, transferred about 150 larvæ to clean water, to which sea salt and a piece of broken-up sod had been added. There was at this time a great difference in the size of the larvæ, indicating a very unequal rate of development.

About this time there was a cold spell, and as there was no heat in the laboratory during the night, growth was very slow and the water tended to become foul. Finally, on the 24th, sixteen days after they were hatched, the larvæ were yet scarcely half-grown, many had died and the remnants were bottled; and thus closed a very interesting experiment, by which it was, for the first time, definitely proved that species of the genus *Culex* lay their eggs singly, in dry or most soil, and that for months they may lie thus, ready to hatch when covered by water of a proper temperature.

Incidentally, the same points are proved for *Culex tæniorhynchus*, assuming that it is really a distinct species.

July 21st, I spent a few hours at Avalon, with Mayor Gilbert S. Smith. The conditions there are not essentially different from those existing at Five Mile Beach, save that there is more opportunity for breeding at the base of the upland; but, on the other hand, tide ditches come to this point, so that drainage into the level meadow will not prove a serious task. All the specimens collected here were such as came to bite, and of these not one had any appearance of developing ova—all were fresh, clean specimens.

August 4th and 5th, was at Beach Haven and examined rather carefully the conditions existing in that immediate vicinity. Did not get north of Barnegat Junction; but south of that point to Beach Haven, and for some distance south from that, breeding places can be completely abolished at very little trouble and expense. The island is very narrow and the marsh area on the bay-side is low, so that even shallow ditches would carry tide-water to the edge of the upland. There is a little series of hollows, made by street and road fillings, which can be very easily filled or drained. It had rained heavily just before I got there, and young larvæ were in all the recently-covered areas. It rained very heavily during one night of my stay, and the next day, wherever there was an inch of water in the meadows, it was swarming with little wrigglers. In the early afternoon much of the area had dried up completely, and the wrigglers were dead, of course—more millions having perished in this way than survived. Where the water had been deeper the larvæ were now much more crowded, as evaporation at the edges drove them to the centre. Had there been a week of wet weather this entire brood would have reached the adult stage.

One lot of twenty-eight mosquitoes was captured in the evening as they came to bite, and one of them succeeded in getting a full stomach before I bottled it. None of the specimens had the ovaries in the least developed.

Another lot of twenty-three specimens was captured at the edge of the marsh land, and of these ten had had a full meal of blood. All save one had undeveloped ovaries, and in that one the eggs were half-grown or more and remains of blood food were evident in the alimentary canal.

The observations made here supplement those made during 1901 at Seaside Park, and show that eggs are everywhere on the lower meadows, and that, wherever the mosquitoes may be in swarms, there they will oviposit. Millions of eggs never hatch at all; other millions

hatch, as did those above mentioned, when rain comes, and perish within a day or two when the water dries off.

August 15th, I was at Lahaway and found everything swarming with *sollicitans.* During two or three days of collecting, Mr. Brakeley and myself found the larvæ of five species of mosquitoes, the adults of which were so scarce as to be hardly noticeable; but not a larva of *sollicitans* was found. A few days before my arrival Mr. Brakeley had collected ninety specimens which came to bite while he stood quietly a few minutes, and these I examined later. Only two of them had succeeded in getting blood, and none of them had developed ova.

I captured 253 examples by sweeping in the grass to make sure of getting gravid females if such there were; but though eighteen examples had feasted upon blood, not one showed any ovarian enlargement. Nor did I capture or see a male during my stay.

August 28th, went to Tuckerton from Philadelphia, and at Whitings *sollicitans* began to come into the train. Before we reached Manahawken it was a nuisance, and thence, to Tuckerton, from half a dozen to a dozen specimens were around almost every passenger. Drove to the edge of the marsh, about six miles from town, and mosquitoes were abundant everywhere. While my driver was explaining to me how sensitive he was to mosquito bites and how much he suffered from them, a specimen alit at the edge of his lower lip, gorged itself with blood and flew away, the speaker remaining completely unconscious of the curious contradiction between his statement and the actual fact. Clouds of mosquitoes arose at the edge of the marsh, and other clouds arose at every step on the way to the De Mott oyster-house. where Dr. Nelson was carrying on his oyster work. About an hour was spent here in collecting, and it was notable that not a male was seen; furthermore, the females had a rubbed and faded appearance, as if they had lived a long time. There had been no rain for some time, and, according to Dr. Nelson, the marsh was drier than it had been at any time during the summer. Only tide-water was found, except a few pools swarming with fish. Twenty-four hours more without rain would dry these pools and kill the fish, leaving excellent breeding places after the next rain. This is a very low, soft marsh, not much above ordinary high tide, with many depressions and holes in which water will stand. Wagon roads lead across it in several directions for carting salt hay, and in these roads wrigglers swarmed earlier when the marsh was wet. Dr. Nelson says that he has crossed this marsh when every hole was full of water and every

pool of water was a mass of wrigglers. In the afternoon skirted the marsh in a gasoline launch with Dr. Nelson and Dr. Lightfoot, to the Mullica river, and afterwards up the Bass river, to the New Gretna landing. The whole marsh was swarming with mosquitoes and was of the same general character as already described; but everywhere the absence of males was noted. From the landing to the hotel at New Gretna was a walk of one and one-half miles through clouds of mosquitoes, and outdoors in the evening was unpleasant to say the least. Yet indoors mosquitoes were few and in the bedrooms none at all, though no especial precautions were taken. Drove from New Gretna to Pleasantville, a distance of sixteen miles, much of it along the edge of the marsh, through mosquitoes everywhere. This area at the mouth of the Mullica river is by all odds the most extensive breeding place I have found, and forms one of the main centers for the distribution of the insects to inland points. The few hours I spent here served only to bring out that fact and pointed to this as a place that must be thoroughly investigated when time and money are available.

One hundred and twenty-four specimens were collected on the marsh, and of these, 117 had neither food remnants nor developing ovaries; two had remnants of blood food, though no ova were obvious; one example had fed upon blood and the ovaries were developing, but the eggs could not yet be counted. In four specimens, in which no food remnants were apparent, the ovaries contained 17, 33, 105 and 113 full-sized eggs, respectively. Except in the last, the eggs were becoming grayish, translucent. I could not determine whether the females containing the small number of eggs had really developed no more or whether some had been previously laid.

Two bits of sod cut out of likely places in the meadow were placed in salt water before I left Dr. Nelson's quarters, but according to his report no larvæ had developed from them more than twenty-four hours afterward.

September 2d I spent at Newburyport, Massachusetts, and on the marshes along that coast, examining a ditching machine; this point will be again referred to, elsewhere.

September 3d, forty-two examples of *sollicitans* were collected for me at Anglesea, and none of these, when examined, showed either food remnants or growing ovaries.

September 11th, Mr. Dickerson went to Anglesea again, and on the 12th collected a series of twenty small sods from half as many differ-

ent places and tested small bits of them in tumblers before bringing them to New Brunswick. Positive results were obtained with eight sods only. There had been heavy rains a few days before, all the lower surface depressions were full of water and all were swarming with small larvæ. Hence, there had been a general recent egg-hatching in the best places.

It may be added here that, from the area where the sods turning out *tæniorhynchus* were obtained, nothing but *sollicitans* had ever been taken from the pools.

The sods were started September 14th, in small battery jars, and larvæ developed in six of them; but the water turned foul very rapidly and I lost every specimen before it became anywhere nearly full-grown.

Of the adults brought up by Mr. Dickerson, thirty-six specimens were examined, and of these twenty-three had undeveloped ovaries and empty crops; nine others had been fully fed, but were otherwise not different; one had a goodly remnant of blood food and half-grown eggs; while three others, though showing no blood remnants, had the ova nearly full-grown and very numerous.

At this time Mr. Brehme's collections were under way, and these are elsewhere reported upon.

October 19th, Mr. Brehme sent me two sods from the Newark meadows; one was taken from the area near Hamburg Place, where so many larvæ had been found; the other came from the Bound Creek district, where, also, larvæ had been numerous and where the meadow had since been burned over.

October 28th, a piece, four inches square, was cut from each of the sods at 11 A. M. and placed in a glass dish, with fresh water. No larvæ developed in either during the day, and next morning both were placed on a radiator, to try the influence of warmth. No better results were obtained in this way, and the effort was abandoned.

November 5th, what remained of each sod was carefully washed, so as to bring all the surface mud into glass dishes, and this material was carefully examined by Mr. Dickerson. Not an egg or an egg fragment was found in either dish.

October 23d, between 4 and 6 P. M., Mr. Dickerson collected 13 males and 119 females at the foot of Hamburg Place, Newark. A slight wind was blowing and the insects did not rise readily until dusk, when he saw them float with the wind for several yards before

attempting to alight. In three only of the females had the eggs begun to enlarge.

October 30th, another collection was made at the same place and sixteen *nigritulus* and forty-six *sollicitans* were obtained. None of the latter had developed eggs and only one had traces of blood food.

Points to be Investigated.

It will appear, from the previous record, that much has been learned concerning this salt marsh mosquito, and much yet remains to be learned. The inability to continue marsh investigations late in fall leaves it a little uncertain under just what conditions the eggs winter. Nor do we know what temperature will bring them out in spring. We know that eggs may lie dry and maintain their vitality for months, hatching within a few hours after they become water-covered; we do not know how long they must lie dry before they can develop if water-covered. We do not know how many broods of the species there are or, under favorable circumstances, can occur. The only period when gravid females were at all abundant was in early July; after that time not a female was found that had black eggs within the body. We do not know how many times an individual may bite, nor whether blood food of any kind is in any way essential to the development of the ovaries. We know that the adults live for weeks; but how long they must live before they can reproduce is yet in doubt. Nor do we know certainly whether all the eggs are laid at one time or whether oviposition extends over any considerable period of time. Of hundreds of females examined in the pines and from points remote from the shore not one had developing ovaries or fully-formed ova. It is scarcely probable that these examples are infertilized, because males are always present in abundance before any females issue. But why do they not lay eggs? The insects occur by the millions throughout the South Jersey swamps and woods; but though there is water in abundance, not a larva has ever been found. Yet the species can and does develop in entirely fresh water along the shore.

The economic bearing of some of these points may not be obvious at first sight; yet, if there is a weak point in the insect's life cycle of which we can take advantage, it will come in connection with the early broods, and the start they get in the spring, and we must know all about that.

Newark Marsh Investigations.

Toward the end of the season, when I felt quite certain as to the general habits of the salt marsh mosquito, I secured the services of Mr. H. H. Brehme, of Newark, a well-known collector of insects and for years a member of the Newark Entomological Society. His assignment was to explore the salt meadow area lying immediately to the east of the cities of Newark and Elizabeth, to determine how much of this land was actually dangerous as breeding ground for the *Culex sollicitans*. From August 19th to October 4th Mr. Brehme was almost daily in the field, and during that time explored most thoroughly the area between the south bank of the Passaic river and the north bank of the Rahway river, and from the Passaic river, Newark bay and Arthur Kill on the east to the highland on the west.

An area of almost twenty square miles of the most difficult territory was closely surveyed in this way, and the breeding places were fully mapped out on separate-sheet maps supplied by the State Geological Survey. A reduced copy of the completed map is reproduced here, to show graphically and at a glance how really small is the actual percentage of dangerous marsh. A closer study will show that many of these bad places lie along the edges of the highland or near to some of the small creeks that cross this marsh, forming natural channels, into which the wet marsh can be drained by cheap ditches.

To ascertain what mosquitoes were flying on the meadows and what species bred there, Mr. Brehme collected adults as well as larvæ, in alcohol, sending in over 200 vials containing many thousands of specimens. All of these were carefully examined by me in the laboratory to verify the species and to ascertain the conditions under which the insects would breed. Quart jars of live wrigglers were sent in two or three times a week from the surveyed areas, and hundreds of adults were bred in the laboratory. It is safe to say that every species that can breed under the marsh conditions was represented.

A few words as to these marsh conditions. Almost the entire area is subject to overflow at storm tides and every part of the marsh is salt. There are a few islands of highland noted on the map, and the actual eastern bank is rarely submerged. All the creeks are tidal and the water is always at least brackish. At the edge of the highland, springs and brooks of fresh water come into the marsh and freshen the creeks at low tide. After a period of low, summer tides

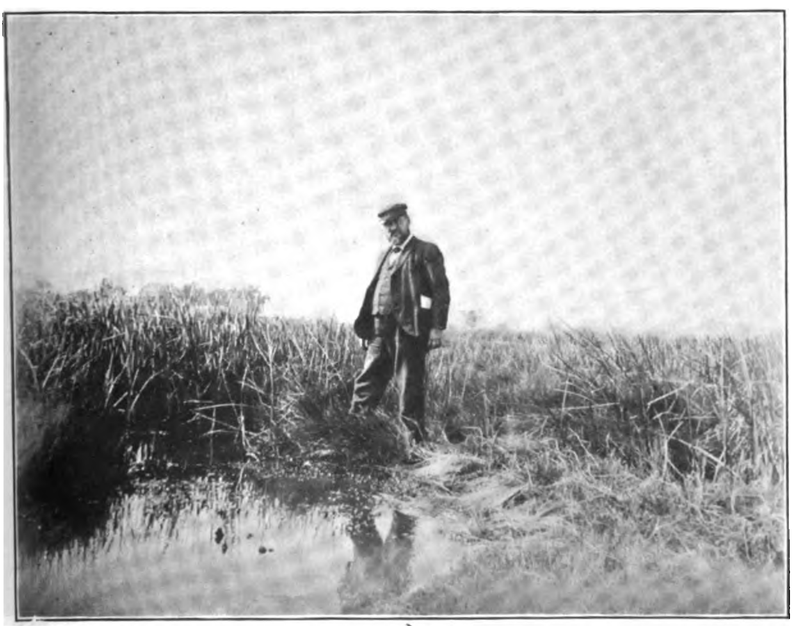

Fig. 3.

Typical breeding pools on the Newark meadows. The upper figure shows Mr. Brehme in collecting attire. From original photographs.

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the water and pools near the highlands is practically fresh. An east wind, with a high tide, may in twelve hours change the whole into salt or brackish water. There are large stretches of the meadow overgrown by cat-tails, six feet or more in height, so densely as to make it impossible to get through, and these generally stand in from one to six inches of water; but no mosquito larvæ have been found in such places by Mr. Johnson, Mr. Brehme, Mr. Dickerson or myself, and each of us have sought diligently and at various seasons.

High, level areas that drain completely after every tide that covers them are safe, of course; and so are those low areas that are covered at every tide, even if by only two or three inches of water. Too many natural enemies exist here to enable mosquito larvæ to exist.

But there are areas of what may be called rotten meadow—just above ordinary high water—full of holes and shallow depressions, where walking is unsafe, and where, except on grass tufts, the boot sinks from four to six inches, leaving a hole that fills at once with water. Extra tides flood these places in spring and leave considerable water areas; some with and some without minnows or "killies" (*Fundulus* Sp.). Wherever the fish occur no mosquito larvæ develop; where none are brought in the pool soon swarms with larvæ, and later adults come in great numbers. Usually a droughty spell comes in early summer, that dries up many of the more shallow pools containing fish, and, of course, kills them as well as any other aquatic animals living there. A heavy rain may fill these pools before another high tide comes in, and there now being no fish, the water soon swarms with wrigglers.

Characteristic mosquito areas and pools are shown at Figure 3, both from the Newark meadows.

Mr. Brehme's Report.

Mr. Brehme's report to me was made partly by letter, partly in a written statement and partly in conferences had with him. To keep the whole in consecutive form and to include the names of the insects taken and observed, his statements and suggestions are here connected and combined. The map (Figure 4) should be consulted in connection with this report.

August 19th, the Great Island area was visited under the impression that it was probably one of the pest-holes in the marsh, but the entire day's work yielded not even one mosquito larva, though adults

were present in large numbers. During that day, 169 small holes, 7 larger ponds and 11 ditches were examined, and, while a few small Hemipterous insects and some aquatic larvæ of Coleoptera and Neuroptera were found, not a wriggler was seen. The meadows here are low, are covered by even ordinary tides, and all the water bodies swarmed with "killies."

Only a few adults were taken, and of these two were *Culex cantans* and eight were *C. sollicitans*. Of the latter, four had not fed at all and the others had fed on something other than blood; in none of them were any ovaries developing.

August 20th, looked over a large area lying between Bound creek, the Pennsylvania railroad and Woodruff creek. There were not so many water bodies here and some places not within reach of the ordinary tides had dried up; others were very low, but everywhere there were "killies." Not a larva was seen or taken in this day's work.

Fourteen adults were sent in; of these only one had fed on blood, and in that one only were the ovaries developing.

August 21st, began at Great island and worked south to Elizabethport. Nothing was found north of Woodruff creek, though there were many pools to be examined. On the south side of Woodruff creek began to find pools containing larvæ, out of reach of tide-water. The samples of larvæ sent in proved, on study, to be *Culex nigritulus*, which, up to that time, had not been known to occur in this country.

Eleven adult *sollicitans* were sent in, and of these nine had the alimentary canal empty and the ovaries entirely undeveloped. One example had the abdomen distended by a blood clot; the ovaries undeveloped. The remaining example had nothing in the alimentary canal, but I counted forty-nine half-grown eggs in the ovaries. It should be understood that when adults are mentioned, females are understood unless otherwise stated.

August 22d, went over the region between Oyster creek, Newark bay and Woodruff creek, east of the Central railroad. No larvæ were found until Woodruff creek was reached, and then, in pools on both sides of that creek, they were plentiful. This breeding area can be very easily drained into Woodruff creek by short ditches. There are some ditches here, but they are partly filled and really make good breeding places for the mosquitoes.

Of the larvæ sent in, one vial contained a number of less than half-grown *sollicitans* and all the others were *nigritulus*.

August 23d, explored the region between Oyster creek, Newark bay and Sloping creek. The meadows here slope and the high tide covers a lot of ground. But it all drains clear at the ebb and there are few holes or pools. No mosquito larvæ were found on this day.

Twenty adult *sollicitans* were sent in, none of which showed developed ovaries, and only two of which showed traces of food in the gut.

August 25th, went to the piece of ground lying between Woodruff creek, Great island and the branch of the Central railroad leading to the Elizabeth race-course. Along a farmer's road, from the almshouse to Great island, are a number of pools, in which no larvæ were found except near Woodruff creek. No others were found until nearing Bound creek, where there is a small danger point, which can be easily drained into Bound creek.

The larvæ taken this day were mostly *territans* and *nigritulus;* one vial contained a brood of very recent *sollicitans* larvæ.

August 26th, worked on the south side of Woodruff creek, west of the Central railroad, to the farmer's road. Between the railroad and the road is the worst breeding place yet found. It is close to the upland and could be easily filled from the highland or drained into the creek. The ground is full of holes and ditches, but the ditches are filled only at extra high tides, and as they do not allow all the water to run off, they really make the worst sort of breeding places. Only a few of the holes and ditches had any fish.

The larvæ collected in this area by Mr. Brehme are mostly *nigritulus,* only a few *territans* being intermingled. Most of the larvæ were full-grown, or nearly so, and there were many pupæ as well.

A large series of adults was collected this day, including *sollicitans, cantans, sylvestris, nigritulus* and *territans.*

Of the *sollicitans,* fifty-one examples had no food in the alimentary canal and the ovaries were in nowise developed; four had fed on blood of some kind, yet had undeveloped ovaries; only one, showing no food remnants in the alimentary canal, had nineteen more than half-grown ova.

August 27th and 28th, covered the ground west from the farmer's road to the Catholic cemetery, finding wrigglers all along the edge of the meadow, in the pools formed there. This entire area should drain into Woodruff creek.

August 29th, completed the work along the edge of the meadow to the Pennsylvania railroad line at Waverly. Larvæ were found

along the edge of the meadow in every pool and ditch. There is a wide ditch running in from Bound creek which can be made of service in draining this area.

August 30th, examined the meadow area near the Pennsylvania railroad, between Peddie Street canal and Wheeler's creek, finding no wrigglers anywhere.

Most of the larvæ brought in from this area were *nigritulus*, with a scattering of *territans* intermixed. In all, there were twenty-two vials in the series of edge of meadow collections; in only three of these were there short-tube larvæ, less than half-grown, which were probably *sylvestris*.

Fourteen bottles of living larvæ were also brought or sent into the laboratory from the same ground, and some adults were bred out of all of them. In all cases the water was at least brackish, and in most it was decidedly salt—even to the taste—as much so as the bay itself. The water in each bottle was tested by the tongue to make this positive.

By far the greatest number of adults bred were *nigritulus; territans* coming in far behind, while a few *sollicitans*, and about as many *sylvestris*, completed the series.

Of the adults collected on the meadow on the 27th there were a few each of *sylvestris* and *cantans*, quite a number of *territans*, and thirty-nine specimens of *sollicitans*. None of the latter had the ovaries at all developed and only three of them had fed, if absence of food remnants can be relied upon.

August 28th, sixty-five examples were sent in, and of these, eighteen were *nigritulus*, one was *sylvestris* and the remainder were *sollicitans*. Of the latter, nine had more or less obvious blood clots or particles in the alimentary canal, and of these, six contained ova less than half-grown. One example, in which the food had been pretty well absorbed, had the eggs more than half-grown, while one other, in which the abdomen was distended with eggs, had no food remnants at all.

September 1st, went by boat to Sloping creek, working inland from it and from the bay shore. Larvæ were found in a few places well up on the meadow, near the creek banks. The land is rather high and the wet area would drain easily into Sloping creek. Some work has been done here by Senator Kean, and when the improvements contemplated by him are completed this breeding area will disappear.

Two vials of larvæ were sent in, of which one contained a large number of *nigritulus* only; the other contained eleven *nigritulus*, one

territans, one *sollicitans.* The adults were, *nigritulus,* eighty-seven, of which fifty-seven were males; *sollicitans,* five, of which two were males. Of the three females, one only had partaken of some vegetable food, while in none were the ovaries at all developed.

September 2d, worked west from Oyster creek to Stoffel creek, which is really only a wide ditch. On the edge of this creek, near the mouth, I found a few pools with wrigglers, but the place is not very bad. Most of the time it is entirely dry, and, as it lies high, it can be easily drained into Stoffel creek.

Of the larvæ sent in all save two were *sollicitans,* and some of these were very small, indicating a recent extension of the pools. The odd larvæ were *territans.*

Of the adults sent in eighty-eight were *nigritulus,* and of these fifty-two were males. There were five *sollicitans,* of which two had remnants of blood food, one of the latter having the abdomen distended with ova that were more than half-grown. The interesting feature in the adult sendings from this region is the predominance of *Culex nigritulus,* which finds in the pools on the high meadows and at the borders of the upland the conditions most suited to it. As the adult of *nigritulus* very closely resembles that of *pungens,* it is more than probable that some of them may, if they get into the town, be counted in with the common species. There were also three specimens of *Anopheles maculipennis.*

September 3d, looked over the stretch along Peddie Street canal and along Dead creek, working towards the upland. A breeding area was found just at the junction of the creek and canal, which can be very completely drained into Dead creek by just cutting through the bank.

In the two vials of larvæ sent in all were *Culex nigritulus.* Among the adults there were two male and five female *sollicitans,* only one of which had fed and none that had the ovaries at all developed. *Culex nigritulus* was represented by twenty males and forty females, while *Anopheles maculipennis* turned out fifteen males and forty-three females. The occurrence of *Anopheles maculipennis* in such numbers and in both sexes points to a local breeding place. Mr. Brehme's instructions did not include search for *Anopheles* larvæ, and the habits of that genus differ sufficiently from those of *Culex* to make the former easily overlooked when the latter only was in view. The occurrence was not unexpected, however, because larvæ were found on this meadow area last year (1901) by Mr. Dickerson.

September 4th, followed the canal to Pierson's creek and beyond it to the Central railroad, and covered the territory northward to the Lehigh Valley railroad. Larvæ were found only along Pierson's creek, toward Maple island and just southeast of the railroad crossing. These areas can be drained into Pierson's creek in one case and into the Lehigh Valley railroad ditch in the other.

All the larvæ sent in were *sollicitans* and most of them were very small. Only one pupa occurred, and it could not be determined what species that represented. The collection of adults consisted, primarily, of *Culex nigritulus,* 115 males and forty females. Next came *Anopheles maculipennis,* twenty-four males and ten females; and lastly, only four *Culex sollicitans,* none of which had either fed or begun to develop ova.

September 5th, covered the ground between Bound creek, Maple creek, Newark bay and the Central railroad. In this area breeding pools are numerous and larvæ plentiful. There are a number of ditches through this place, but they are not properly placed, not deep enough and do not drain the water. The land is too high for ordinary tides, and there are no fish even in the ditches. Relief here would be by deeper ditches into Bound and Maple creeks.

Five vials of larvæ, containing about 150 specimens, were sent in, and all were *sollicitans.* They ranged in size from very small to nearly full-grown. The adults sent in were *Culex nigritulus,* ten males and thirty-one females; *Anopheles maculipennis,* six males and twenty females; *Culex sollicitans,* two females, neither of which had either food remnants or developed ova.

September 6th, on the night from the 5th to the 6th there was an extra high tide that flooded the meadows and left pools all over the covered area in every depression that could not drain off readily. It was the water-supply for which millions of eggs on the meadow had been waiting!

On that day covered the area between Maple creek, Peddie Street canal and the Central railroad. Wrigglers were found in pools along a ditch filled with "killies;" but unfortunately there was no connection between the ditch and the breeding pools.

Four vials of larvæ were received, all of them *sollicitans* and many of them not twenty-four hours old. Of the adults there were *Culex nigritulus,* eleven males and forty-eight females; *Anopheles maculipennis,* twenty-two females; *Culex sollicitans,* five females, none of which had obvious ova, while two had fed on blood.

September 8th, worked on a piece of land lying between the Passaic river, the Central railroad, Hamburg Place and the Newark and New York railroad. This was the worst place thus far discovered, and wrigglers were there in millions. The area is a piece of what I have called rotten marsh and ideal for mosquito multiplication.

Eight vials of larvæ were sent in, containing in the aggregate 630 specimens, all of them *sollicitans.* With few exceptions, these specimens were less than half-grown.

September 9th was an unfit day and brought to head another experiment begun on the 1st, when Mr. Brehme allowed one dozen *Culex sollicitans* to gorge upon his blood, capturing each individual in a separate vial and afterward turning them loose in large jars at his home. On the 8th all were dead, and on the 9th were bottled and sent to me. Three had fallen into the water dish in the prison jars and were not sent. Of the remainder, six did not show any blood remnants in the alimentary canal, and in none had the ova begun to increase in size. The other three were equally devoid of food remnants, but in two the ova were more than half-grown, and in the third the eggs were full-grown and getting into the transparent gray stage.

The experiment did not result quite as I had hoped, but showed at least that in a period of seven days a full blood-meal can be completely digested and excreted.

September 10th, continued the exploration of the area entered on the 8th, and toward the mainland it grew ever worse, the pools being simply black with larvæ. Mr. Brehme said he had never seen larvæ so abundant before—in a dip with his little coffee-strainer, he obtained twenty to twenty-five each time—with his net he could get a pint of larvæ at a single stroke. Another point noted was that, while larvæ were very plentiful, adults were rare and not at all troublesome. A ditch, with a strong flow of water, runs within fifty feet of the worst of this area.

Ten vials of wrigglers were sent in, all of them *sollicitans,* few of them much more than half-grown and aggregating a little over 1,000 specimens.

It was at this time, when the uniform size of the larvæ from so large an area attracted attention, that I began to inquire what had happened a few days ago and learned of the heavy tide of the 5th inst.

September 11th, found conditions south of Hamburg Place not quite so bad as on the north, but yet with numerous areas of the

same general character. After determinating this point went to Pierson's creek, about a mile to the south, to see if there were larvæ in the pools filled by the tide on the 5th. There were wrigglers there, but also "killies," and very few were collected. These were separately tubed and turned out—*sollicitans,* ten, mostly small; *nigritulus,* six, mostly large.

The larvæ collected on the 11th were in fourteen vials and aggregated 1,277 specimens, of which two were separated as probable *sylvestris,* and all the others were *sollicitans.* Adults were reported as rare at this time, and the captures for the 10th and 11th numbered only fifty-three, of which six were *nigritulus.* Of *sollicitans,* there were twenty-one males and twenty-six females, and of the females, seven had the ovaries entirely undeveloped. In fifteen the eggs were less than half-grown and no food remnants could be found; in one specimen, in which the ovarian development was about the same, there was an appearance of vegetable food, and in two others, where the eggs were much less than half-grown, traces of blood were obvious. One other example had eighty-nine just countable eggs and no appearance of recent food.

September 12th, continued the exploration south of Hamburg Place to the bay and wrigglers were found in every pool. Eight vials were brought in, all *sollicitans,* but now beginning to pupate; in all, 436 specimens, of which twelve were pupæ. Adults were all *sollicitans,* forty-three males and sixteen females. Of the latter, eleven had not fed, nor had ovarian development begun; in four the eggs had begun to grow, but no food was found; in one example, in which the ova were half-grown, remnants of blood food were identified.

September 13th, Mr. Brehme collected and brought to New Brunswick some jars of living wrigglers from the Hamburg Place area. He reported that the larvæ were now full-grown and that the change to pupal form was becoming general; a statement borne out by his specimens. He added, also, that the breeding pools were becoming smaller and, unless refilled, could not last many more days.

I was not quite satisfied, after discussing the matter with Mr. Brehme, that the area first examined in August was always so free as he had found it at that time; so, as there had been a high tide and two heavy rains of late, he went again over the region between Woodruff creek, Oyster creek, Newark bay and the Central railroad. The meadows were very dry, even after the heavy rain on Saturday

(13th), and very few pools were found. The first larvæ were found near Wood creek, in one of a series of pools, and this was the only one that had no fish. No more wrigglers were seen until another pool area was found, near Oyster creek. Here a pool, 7 x 3 feet, was filled with them, but they had only about three-fourths to one inch of water and mud, which would be entirely dry in twenty-four hours, long before the larvæ could possibly reach the pupal stage. Similar conditions were found in a number of other pools. The pool first found is only about twenty feet away from a tide ditch containing fish, and fish were in pools 100 feet away. Mr. Brehme's conclusion is that this place cannot become bad in an ordinarily dry season because all the larger, more permanent pools are connected by little channels with main ditches and always contain fish.

All the larvæ sent in were *sollicitans*. Of the adults there were twenty-one male and twenty-one female *Culex nigritulus;* tweve female *Anopheles maculipennis,* and a few *Culex sollicitans,* which, by accident, were not counted or examined.

September 16th, I visited the Hamburg Place area with Mr. Brehme, and found the pools fast disappearing, while pupæ rather than larvæ were the rule. On the 11th and 12th Mr. Brehme had noted the rarity of adults; on the 16th they simply swarmed and made continuous fanning necessary to keep them off. The number was constantly increasing, and males as well as females were present in great quantity. It would be difficult to estimate the number of specimens bred out of this Hamburg Place area, and I doubt whether it can be done in terms of less than eight or even nine figures.

This case, however, illustrates the occurrence of a typical swarm. The period preceding September 5th had been dry and hot, and the meadow was dry, the adult mosquitoes few in number and dying off as their eggs were laid.

The very high tide of the 5th brought in the necessary water, soaked the marsh and left many pool areas without fish, in which eggs at once hatched and larvæ were already present on the 6th. Pupation began on the 12th and 13th, and by the 16h the great bulk was in the adult condition. Until this tide came the meadow was safe, and had there been any provision for even slow drainage, it would have remained so. The occurrence of two days of heavy rain probably prolonged the life of many pools sufficiently to enable them to mature their crop of larvæ.

In the afternoon Mr. Brehme made a preliminary exploration along the north bank of the Elizabeth river, near its mouth. He found there conditions as bad or worse than those on the Hamburg Place area. The character of the meadow is the same and the stage of development was also the same. Quite evidently, the same tide that supplied Newark was equally good to Elizabeth. Mr. Brehme speaks of adults by the million, and determined at once that to the south Elizabeth had a much greater source of danger than to the east.

I wrote a brief note of this occurrence to Dr. Robinson, at Elizabeth, and predicted that the next south wind would fill the city with salt marsh mosquitoes. It was a safe prediction, and was promptly verified.

Of the few larvæ taken all save three were *sollicitans;* the three oddities proved *nigritulus.* The adults were two male and five female *nigritulus;* eleven male and nineteen female *sollicitans.* Of the latter fifteen had undeveloped ovaries and no food remnants; one had a blood clot filling, but no developing ova; two had developing ova, without obvious food remnants, and one had the eggs half-grown, with remnants of blood food in the alimentary canal.

September 17th, worked along the Passaic river, between the plank road and the Newark and New York railroad. This place is well drained and wrigglers were found in only one pool, which was fast drying up. Worked, also, along the south side of the railroad, where nothing but cat-tails grow, and went through the whole place, just to see if mosquitoes do breed in such places, but found not even a sign of a wriggler.

Only two *sollicitans* and two *nigritulus* larvæ were sent in, but there were about thirty pupæ and pupa shells, probably *sollicitans.* Of the adults one male and eight females were *nigritulus;* thirteen males and seventeen females were *sollicitans.* Of the female *sollicitans* nine had neither eggs nor food remnants apparent; two had blood food, but no developing ova; three had the ovaries increased in size, but were without food; two had remnants of blood food and ova two-thirds-grown; one, in which the alimentary canal was clear, had the eggs full-grown, the shell becoming gray, translucent.

September 18th, finished up the north end of the Newark meadow, north of the plank road, and found it safe and well-drained. There was only one small pool that fills at extra high tide, and this had a few wrigglers.

In the afternoon revisited the territory explored September 5th, to see if it was as bad as it was then; found that it was, and that all the

pools were full of larvæ. This is a continuous breeding area, and the meadow is comparatively low and wet.

Of the larvæ sent in—the vial from the north meadow area—one was *sollicitans* and five were *nigritulus*. The afternoon's collecting was all *sollicitans,* consisting of 112 larvæ and fifty-one pupæ. The adults were *Anopheles maculipennis,* three males; *Culex nigritulus,* two males and three females; *Culex sollicitans,* sixteen males and twenty-four females. Of the female *sollicitans* sixteen showed neither food nor developed ova; four had eggs varying from half to nearly full-grown, without food remnants; one had a blood-distended abdomen, containing no developed eggs, and three had remnants of blood food, with eggs half-grown or more.

September 19th, worked along the north side of the Elizabeth river, west of the New York and Long Branch railroad, and found two rather bad breeding areas, but not so bad as those at the mouth of the river. This area can be very easily drained into the Elizabeth river.

All the larvæ and pupæ, 217 in number, were *sollicitans.* The adults—thirteen males and nineteen females—were also *sollicitans.* Of the females twelve had neither food nor developing ova; two had developing ova, without food remnants, and five had eggs half-grown or more, with remnants of blood food.

September 20th, explored the territory lying on the south side of the Elizabeth river and east of the New York and Long Branch railroad. This is not so bad as the north side of the river, but many pools were found in which wrigglers occurred in great quantity. The whole of this area drains naturally towards the Elizabeth river.

Of the larvæ sent in thirty-two were *sollicitans* and five were *nigritulus.* Of the adults one male and two females were *nigritulus* and eleven females were *sollicitans.* The latter, to all appearances, had neither fed nor had they developed ovaries.

September 21st was Sunday, and Mr. Brehme went fishing instead of hunting; but he combined business with pleasure, and made one of the most important observations of his season. I give it nearly as he states it: "I was down the Bound creek yesterday, fishing for tom-cod. When I went down along Maple creek at 6 A. M. I saw a pool that was filled with wrigglers. I noticed that we had one of the highest tides that I have seen since 1895, so I thought, while fishing, that it would be a good idea to make a search over the meadows and see if any 'killies' were thrown in on the highest points between Maple

and Bound creeks. After I got through fishing, when the tide had run out five hours and the fish did not bite any more, I took a look at the places. To my surprise, I found the places that were nearly dry this morning filled with water and hundreds of 'killies' in the pools. I looked closely, to find the wrigglers which I had seen only nine hours before, but did not find even one. In the one pool where I had seen so many there were at least 200 'killies.' So, draining this place just a little would certainly do away with the mosquito breeding."

September 22d, worked along the south side of the Elizabeth river, west of the New York and Long Branch railroad. It is certainly a bad spot, and quite a number of pools containing wrigglers was found. But the water was again unusually high, and the meadows were so deeply covered that progress was slow and many points could not be reached at all.

Of the larvæ sent in two vials contained *sollicitans* only; the third contained twenty-one *sollicitans* and five *nigritulus;* the fourth had twelve examples of a species very like *sollicitans,* but which I recognized as distinct. Later, I bred from this larva an adult, that was determined as *sylvestris,* and so the species will be referred to here. There was also a larva of *Anopheles maculipennis* in this fourth bottle. The adults taken were *nigritulus,* three males and two females; *sollicitans,* ten males and sixteen females. Of the female *sollicitans* eleven had not fed recently and the ovaries were undevloped; in one the ova had just begun to enlarge, though no food remnants were found, and in four there were half-grown ova and remnants of blood food.

September 23d, went along the south side of the Elizabeth river, from Arthur Kill west to the place reached on the 20th. This is another bad spot, and wrigglers were found everywhere, in every pool, even though it was very high water. During the day, though the meadow was everywhere covered by recent tide pools, very few "killies" were seen. Drainage of this area can be made to the Kill and to the river.

Three vials of larvæ sent in, and, with one exception, all were *sylvestris;* there was one *nigritulus.* Of the few adults taken three males and three females were *nigritulus;* eight females were *sollicitans.* None of the latter had the ovaries at all developed, though three had the abdomen distended by blood clots.

September 24th, worked along the west end of the Elizabeth river as far as meadow land is found. This area is not so wet as farther down, though there are many pools that seem just about right for

wrigglers. Yet there are not so many there, and the place is not near so bad as down stream. And this completes the survey of the area at the mouth of the Elizabeth river.

Three vials of larvæ were sent in, and all save three were *sylvestris.* Of the three, two were *nigritulus* and one was *sollicitans.* Of the adults, four males and two females were *nigritulus;* twelve males and thirteen females were *sollicitans.* The female *sollicitans* showed neither food remnants nor developing ovaries.

September 25th was a very rainy day, and Mr. Brehme gave it up at 1 P. M., when thoroughly soaked. The time was put in near Morse's creek, about one mile south of the Elizabeth river. There were numerous pools here filled with very small wrigglers, only two or three days old, and, while the day was not favorable for close observation, enough was seen to show that this area is ideal for mosquitoes. There are a number of large ditches through it, and into these and the creek the land could be readily drained.

Four vials of larvæ were sent in, each taken from one pool and showing quite a variety. No. 156 had *sollicitans,* twenty-nine; *territans,* three; *nigritulus,* nine; *sylvestris,* seven. No. 157 had *sylvestris,* seventeen; *nigritulus,* one; *sollicitans,* three. No. 158 had *sollicitans,* thirty-three (all small). No. 159 had *sylvestris* only. Of the adults, one was *Anopheles maculipennis,* male; there were one male and two female *Culex nigritulus;* fourteen male and twelve female *sollicitans.* Only one female *sollicitans* showed developing ova, and this was also the only specimen in which food remnants were found.

September 26th was too stormy for even Mr. Brehme to venture out, and on the 27th he covered a thertofore unexplored part of the Newark meadow, between Peddie Street canal and Bound creek, east of the Pennsylvania railroad. No breeding places were found in the accessible parts of this area; but recent high tides and heavy rainfall had flooded everything and a large portion of the meadow was covered by from four to six inches of water.

September 29th, covered the territory on the west side of the New York and Long Branch railroad, on both sides of Morse's creek, down as far as Morse's Mills. The pools found during the morning all had "killies," and no wrigglers were found; but after midday, working ing in toward the highlands they were found in numbers. Working along the meadows, found wrigglers, large and small, in great numbers, and at least three kinds. At least 95 per cent. of the larvæ are

small and they are scattered everywhere and everything is covered with water. When the water gets down to its normal condition there will be wrigglers by the million, and this will be the largest brood of the season.

Seven vials were sent in, containing over 200 larvæ. Of these. four were *Anopheles maculipennis,* two were *Culex territans,* fourteen were *C. nigritulus* and all the rest were *sollicitans,* mostly small or very small.

Evidently the high water and heavy storms of the preceding week had caused the hatching of all the eggs then on the meadow. Adults of the preceding brood were yet present "by the million" and 108 examples were sent in. Of these, four were *nigritulus* and all the rest *sollicitans*; forty-nine males and fifty-five females. Of the latter, thirty had neither food remnants nor developing ovaries; eight had recently fed upon blood, and the ovaries were beginning to develop; eight others had remnants of blood food only, and the ova were half or more developed. In seven examples, the eggs were nearly or quite full-grown, but yet white, and in three of these remnants of blood food were found.

September 30th, a large area was covered extending between Arthur Kill and the New York and Long Branch railroad, from Morse's creek to a creek not named on the map, and west of the railroad to the upland. In the entire area east of the railroad only two small breeding pools were found, and these can be easily filled from the highland right there. West of the railroad larvæ were again found at the edge of the upland.

On the return, a lot of living larvæ were collected on the area covered September 23d, and these were sent to me that I might secure adults of the *sylvestris* breeding there. Mr. Brehme notes that the larvæ were much reduced in number and that the high tides since his previous exploration had thrown at least 100 per cent. more "killies" into the pools.

Five vials of larvæ were sent in, containing 147 specimens. Of these, three were *territans,* six *nigritulus,* and all the others *sollicitans.* Of the adults all were *sollicitans;* forty-four males and thirty-nine females. Of the females, twenty-eight had neither food nor developed ova, nine had food remnants, with eggs half-grown or less, and two had the eggs fully developed, beginning to turn gray, and no trace of food remnants.

October 1st it was raining, but Mr. Brehme worked on the south

side of the unnamed creek, both east and west of the railroad. East of the railroad nothing was found, nor was any breeding place discovered on the west side until the edge of the highland was reached. This territory has been ditched at some time, and the breeding places that remain can be easily drained into these ditches or into the large creek.

Six vials of larvæ were sent in, aggregating 147 specimens. Of these, twenty were *territans*, twelve were *nigritulus*, and the remainder were *sollicitans*, many of them small and with possibly some *sylvestris* intermixed. Of the adults, fourteen males and ten females were *nigritulus;* twenty males and sixteen females were *sollicitans*. Of the latter, eleven females had not fed, to all appearance, and the ovaries were undeveloped. Five had fed, but in only one example had the eggs begun to enlarge.

October 2d, covered the territory between the Sound Shore railroad and Tremley. In the low meadows no wrigglers were found; but along the highland there were plenty of them. This area has two creeks, the Arthur Kill and several ditches to carry off the breeding pools.

Eight vials of larvæ were sent in, aggregating 204 specimens. Of these, five were *territans*, seventy-three were *sollicitans* and the remainder were *sylvestris*. Of the adults, five males and fourteen females were *nigritulus* and twenty-two, all females, were *sollicitans*. The latter were not examined as to food or ovarian development.

October 3d, finished the lower corner of the meadow about Tremley, to the Rahway river. One little breeding area was found on the Sound Shore railroad, and the usual areas along the highland. This portion of the meadow drains into the Kill or into the Rahway river.

Eight vials of larvæ were sent in, aggregating 297 specimens. Of these, one was *territans*, one was *nigritulus*, eleven were *sollicitans* and all the remainder were *sylvestris*. The *sollicitans* and *nigritulus* were taken near the Sound Shore railroad, and all the others along the highland.

October 4th, collections were made along the Elizabeth river, and a lot of living material was secured for me. Two vials of larvæ were collected in alcohol, and all of these were *sylvestris*. The living material, however, bred out *sollicitans*, *sylvestris* and *nigritulus*, the former being in the minority, with eighteen adults as against sixty-three of the others.

Besides the living material actually mentioned, Mr. Brehme sent

in other bottles from time to time. Mr. Dickerson came daily from Newark to New Brunswick, and Mr. Brehme met him at the railroad station with such material as was to be brought on. I was thus in constant communication with Mr. Brehme, and as soon as I noted any unusual form of larva in the alcoholic material could secure a lot of living specimens from the same area. Mr. Brehme also gathered in some of the natural enemies living in the same pools with the wrigglers, but as any close collecting would have consumed too much time, very little stress was placed on this point.

The survey was intended primarily to locate breeding places and to ascertain just how much of a task is really before us in our effort to clear the ground. I believe that the result is decidedly encouraging and shows that the burden will not be nearly so great as was believed. Several scientific questions were left unsettled because of the impossibility of continuing the work after October 4th, but this does not impair the practical result obtained.

One further word regarding the collections: It would have been possible, of course, to secure much greater numbers of larvæ in each case, but Mr. Brehme was instructed to merely sample characteristic pools in each breeding area, that the dominant species in each locality might be indicated; and so, in the collection of adults, only enough were taken to show what species were flying.

A very important outcome of the survey is the fact that *Anopheles maculipennis* occurs on these marshes in considerable numbers and breeds there. This is the species of which it has been definitely proved that it is a transmitter of malarial fevers, and any large establishments built on this area before it is drained would almost certainly introduce malaria in an unpleasantly epidemic form.

Elizabeth City Collections.

At my request, Mr. Otto Buchholz, living on Adams avenue, Elizabeth, collected for me at intervals of about five days, from June 20th to October 19th, samples of the mosquitoes occurring in and about his house. The objects were to ascertain—*first,* the dominant species of the year; *second,* whether the same species occurred in equal proportions indoor and out. Therefore, the specimens collected in the house were kept carefully separated from the others, and the outside collections were made near to the house itself. The following lists are instructive:

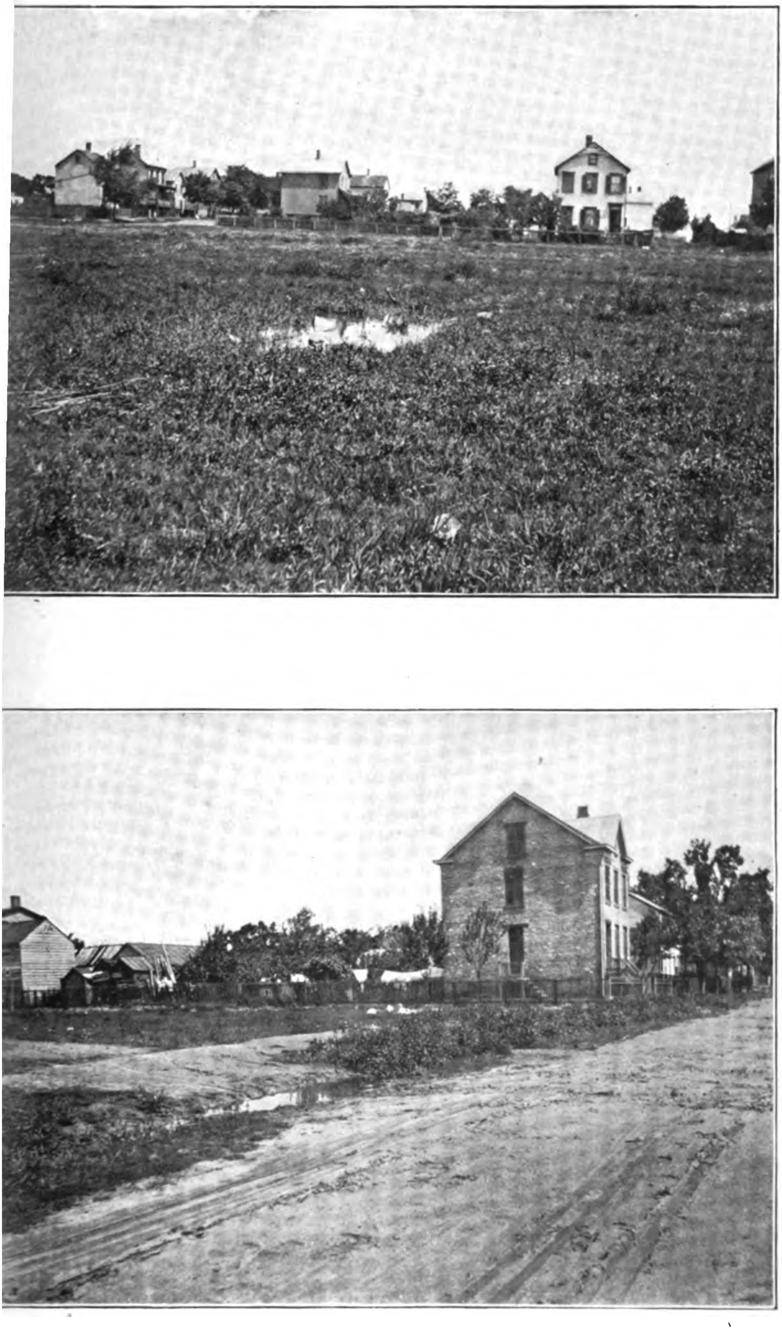

Fig. 5.

Mosquito Breeding Places in New Brunswick The upper figure shows a typical vacant-lot pool from which thousands of the insects emerge, and which could be easily filled; the lower figure shows a neglected gutter, partly overgrown and forming pools in which water remains for weeks. From original photographs.

Out-door Collections.

June 20.	Culex sollicitans, all females	40	
	" cantans, all females	4	
	" pungens 5 males, 5 females	10	54
" 25.	" pungens, 109 males, 2 females	111	
	" sollicitans, all females	6	117
" 30.	" sollicitans, all females	12	
	" pungens, 1 male, 17 females	18	30
July 5.	" sollicitans, all females	24	
	" pungens, 29 males, 6 females	35	
	" cantans, all females	4	63
" 10.	" pungens, 118 males, 18 females	136	
	" sollicitans, all females	8	144
" 15.	" pungens, 16 males, 8 females	24	
	" sollicitans, all females	5	29
" 20.	" pungens, 22 males, 27 females	49	
	" sollicitans, all females	4	53
" 25.	" sollicitans, all females	4	
	" pungens, 3 males, 14 females	17	21
Aug. 5.	" sollicitans all females	20	
	" sylvestris, all females	11	
	" pungens, all females	2	33
" 10.	" sollicitans, all females	19	
	" sylvestris, all females	5	
	" pungens, all females	4	28
" 15.	" sollicitans, all females	26	
	" sylvestris, all females	16	
	" pungens, all females	3	
	Anopheles punctipennis, females	2	47
" 20.	Culex sollicitans, all females	12	
	" sylves ris, 2 males, 12 females	14	
	" pungens, all females	4	
	Psorophora ciliata, female	1	31
" 25.	Culex sollicitans, all females	16	
	" sylvestris, 9 males, 46 females	55	
	" pungens, all females	6	
	" territans, female	1	78

Aug. 30.	Culex sollicitans, 1 male, 7 females	8	
	" sylvestris, all females	7	
	" pungens, 6 males, 29 females	35	
	Anopheles punctipennis, female	1	
			51
Sept 1.	Culex sollicitans, all females	6	
	" cantans, 7 males, 16 females	23	
	" sylvestris, 3 males, 2 females	5	
			34
" 5.	" cantans, all females	2	
	" pungens, 9 males, 1 female	10	
			12
" 10.	" pungens, 12 males, 5 females		17
" 15.	" sollicitans, all females	3	
	" cantans, all males	2	
	" pungens, all males	5	
			10
" 20.	" sollicitans, 2 males, 20 females	22	
	" sylvestris, 1 male, 4 females	5	
	" pungens, 15 males, 26 females	41	
	Anopheles punctipennis, female	1	
			69
" 25.	Culex sollicitans, 1 male, 7 females	8	
	" pungens, 5 males, 9 females	14	
	Anopheles punctipennis, female	1	
			23
" 30.	Culex sollicitans, 1 male, 2 females	3	
	" pungens, 5 males, 15 females	20	
	" cantans, 1 male, 2 females	3	
			26
Oct. 5.	" pungens, 2 males, 16 females	18	
	" sylvestris, female	1	
			19
" 19.	" pungens, 1 male, 34 females	35	
	" cantans, 1 male, 4 females	5	
			40
	Altogether		1,029

These specimens are divided, as to species and sexes, as follows:

Culex sollicitans,	males, 5;	females, 241	246
" cantans,	" 11;	" 32	43
" sylvestris,	" 15;	" 104	119
" pungens,	" 363;	" 251	614
" territans,		" 1	1
Anopheles punctipennis,		" 5	5
Psorophora ciliata,		" 1	1
			1,029

This shows strikingly that *pungens* is a local species, more than half of the specimens being males, while *sollicitans* is an intruder, only five males out of 246 specimens being taken during the season. *Cantans* and *sylvestris* breed closer by, and probably within the city limits.

From the large number of male *pungens* taken, it is probable that there is a local breeding point for that species close to where the collections were made, and that the species is unduly represented for that reason. It is also possible that some of the specimens called *pungens* are really *territans;* indeed, it is almost certain that such is the case, but the material examined was in alcohol and discrimination is not easy.

The list of indoor captures is as follows:

June 20.	Culex cantans	2	females.	
	" pungens	3	"	
	" sollicitans	2	"	
		—		7
" 25.	" pungens	5	"	
	" sollicitans	2	"	
		—		7
" 30.	" pungens	6	"	
	" sollicitans	1	"	
		—		7
July 5.	" pungens	5	"	
	" sollicitans	3	"	
		—		8
" 10.	" pungens	26	"	
	" sollicitans	1	"	
		—		27
" 15.	" pungens	17	"	17
" 20.	" pungens	11	"	11
" 25.	" pungens	13	"	13
" 30.	" pungens	20	"	
	" sollicitans	1	"	
		—		21
Aug. 5.	" pungens	22	"	22
" 10.	" pungens	14	"	14
" 15.	" pungens	22	"	22
" 20.	" pungens	18	"	18
" 25.	" pungens	16	"	
	Psorophora ciliata	1	"	
		—		17
" 30.	Culex pungens	17	"	
	" sylvestris	1	"	
		—		18

Sept.	5.	Culex pungens		6	females.	6
"	10.	" pungens		16	"	16
"	15.	" pungens		5	"	
		Anopheles maculipennis		1	"	
				—		6
"	20.	Culex pungens		10	"	
		" territans		6	"	
		Anopheles maculipennis		1	"	
				—		17
"	25.	Culex pungens		6	"	
		" sollicitans		2	"	
				—		8
"	30.	" pungens		10	"	
		" territans		7	"	
				—		17
Oct.	5.	" pungens		5	"	5
"	10.	" pungens	1 male,	3	"	
		Anopheles maculipennis		1	"	
				—		5
"	19.	Culex pungens	1 male,	8	"	9
		Altogether				318

Divided as to species, we get—

Culex pungens	286
" sollicitans	12
" cantans	2
" sylvestris	1
" territans	13
Anopheles maculipennis	3
Psorophora ciliata	1
Total	318

In other words, while outdoors the females of *pungens* and *sollicitans* were in almost equal numbers, only twelve *sollicitans* out of a total of over 300 were found indoors.

In all, 1,347 specimens were examined, and the justice of the title "house mosquito" for *pungens* is fully demonstrated. It is absolutely necessary, to secure indoor comfort, that the local breeding places of this species must be destroyed or treated. It is absolutely necessary, to secure outdoor comfort, that the salt marsh species be dealt with. As to the local breeding places in Elizabeth, the report made by Dr. Wm. F. Robinson to the organization that conducted the mosquito campaign in that city gives useful information. The sewer catch-basin as a mosquito breeder is very prominently brought out in that report, and this point is of great importance to any similar organization that may be hereafter formed to deal with local conditions.

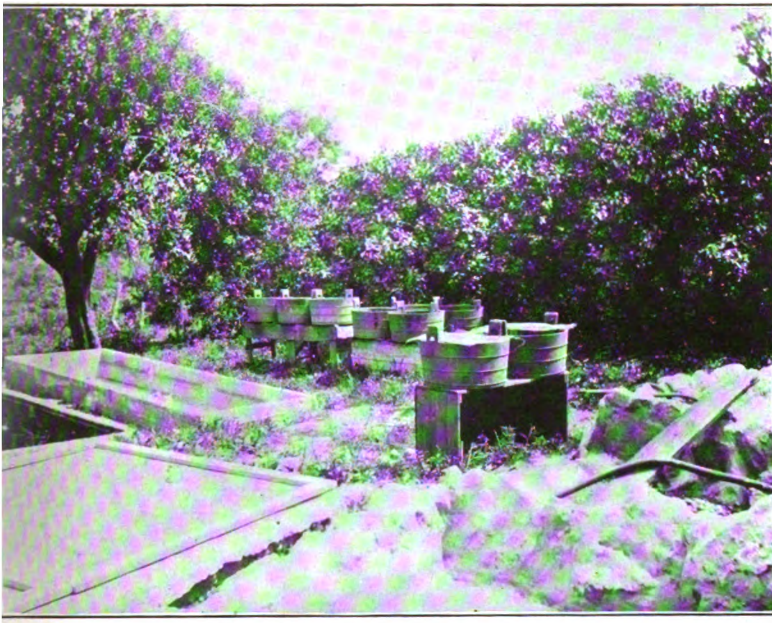

Fig. 6.

Upper figure represents the Experiment Tubs at Delair; the lower, the Breeding Pails at New Brunswick. From original photographs.

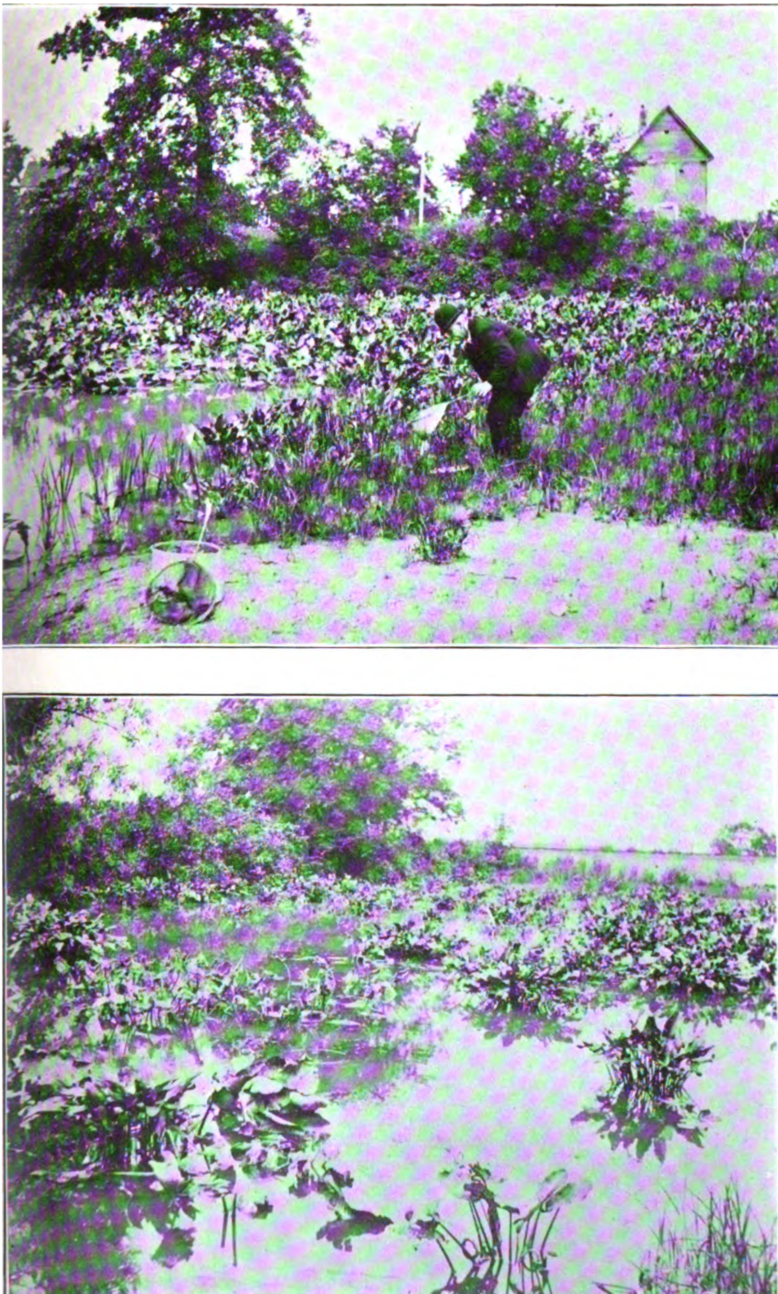

Fig. 7.

Breeding Places for Anopheles. In the upper figure Mr. Seal is standing in the shallow grassy margin where larvæ are numerous; the lower figure shows more open water, where fish can get freely and where few larvæ occur. From original photographs.

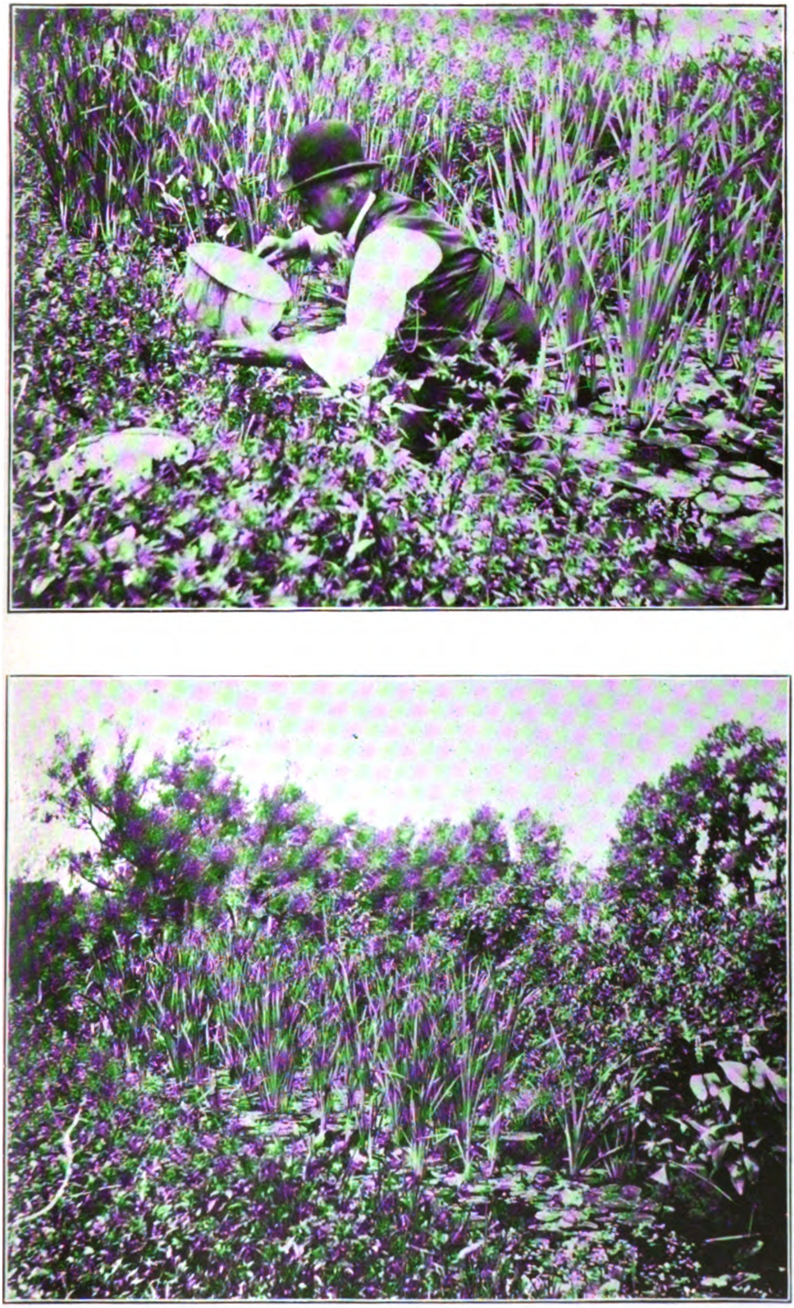

Fig. 8.

Open swamp area making excellent places for Anopheles breeding. The upper figure shows Mr. Seal among the rushes and lily pads collecting larvæ. From original photographs.

This particular sort of breeding place is easily dealt with by the municipalities where it occurs, and the process may include either actual disinfection or a mere oiling to stop breeding.

Drainage.

It has appeared again and again in this report that drainage, or ditching, is the method by which bad breeding areas are to be redeemed and made harmless. The matter of cost will always be an important consideration in all work to be undertaken; hence, when I learned that at Newburyport, Massachusetts, there was a practical machine for cutting drainage ditches in salt marshes, I went to that city September 2d, and saw Mr. Mark B. True, the inventor. Plate 9 gives a fair representation of the hand-power machine, as it now stands on the Salisbury marshes. This machine has been in service over twenty years and does good work yet; a much larger power machine was also seen, but in such position that it could not be photographed. This machine cuts ditches four to eight inches wide, two to three feet deep, at the rate of about forty to 100 rods per day, with a crew of four men, of whom two work the wheel and two move the tracks upon which the machine runs. Improvements recently made have improved its efficiency to such an extent that the persons owning the patents offer to take contracts for ditching at ten cents per rod. At this rate, areas like those about Newark and Elizabeth could be thoroughly drained for a few hundred dollars and the work would be done for good. Even such marsh areas as those at the mouth of the Mullica river lose their terrors, while such strips as those on the bay-side of the Barnegat island can be thoroughly freed of breeding places at a sum that would be made up by the increased hotel patronage in one season. This subject is scarcely ripe for final treatment at present, but the possibility of effective cheap ditching in necessary areas only, will bring the whole problem down to a simple business proposition. There is no question of the possibility of accomplishing the end—the only question is one of cost.

It is unfortunate, perhaps, that the owners of the True ditcher refuse to sell machines; they prefer to secure contracts to do the work, and, of course, will scarcely care to undertake to drain an area which is not large enough to make it pay to bring their machines down.

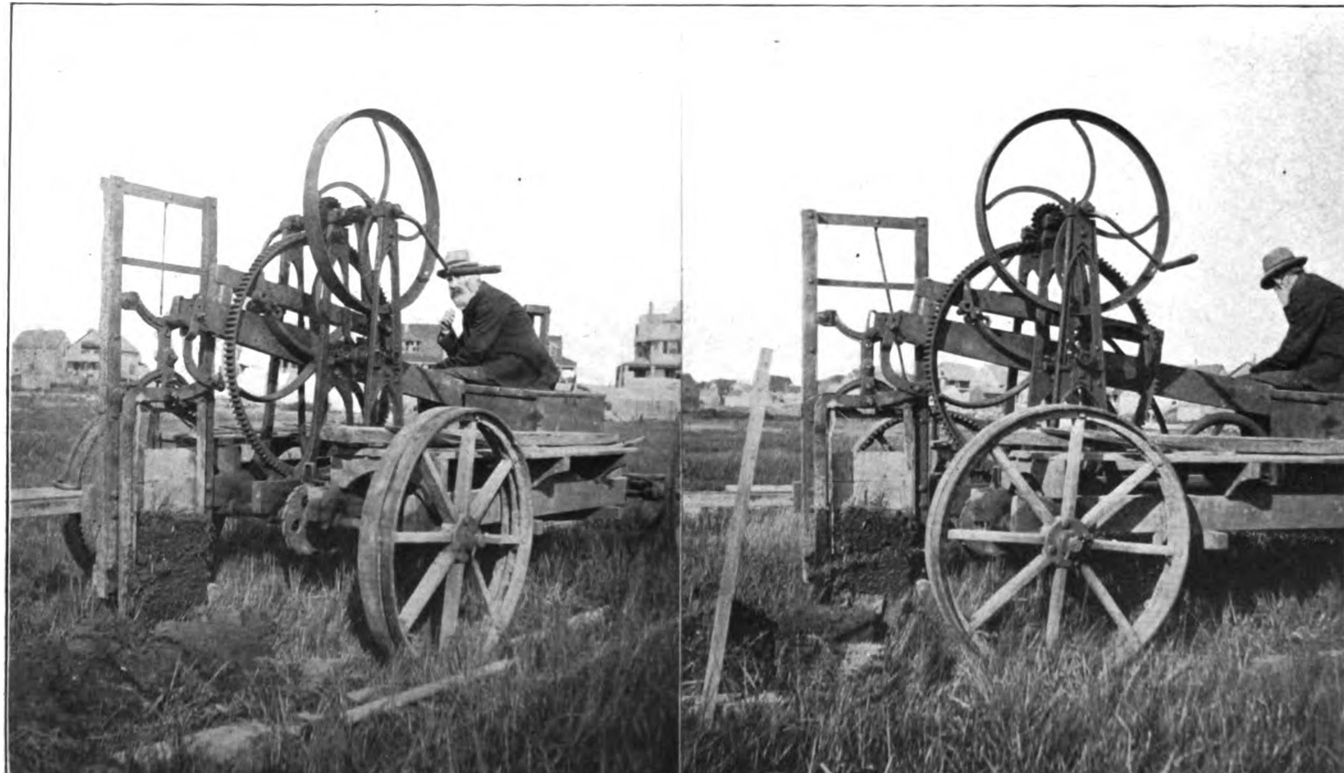

Fig. 9.

The True Ditcher from two points of view, showing a sod partly lifted out. From an original photograph

APPENDIX A.

A STUDY OF CERTAIN MOSQUITOES IN NEW JERSEY,* AND A STATEMENT OF THE "MOSQUITO-MALARIA-THEORY."

HERBERT PARLIN JOHNSON, PH.D.

Introduction.

The following studies were undertaken as a part of the investigations conducted during the summer of 1902 by Dr. John B. Smith, with the object of devising ways and means of abating the mosquito nuisance and malaria in New Jersey. My subject was the relation between the prevalence of malaria and abundance of mosquitoes of the genus *Anopheles,* and the particular problem in hand was to determine whether *Anopheles punctipennis* is a carrier of malaria. The gathering of data regarding the breeding habits, distribution, etc., of our common mosquitoes also came within the scope of the season's work.

Of the three species of *Anopheles* found in New Jersey, only *Anopheles maculipennis* is positively known to be a carrier of malaria. *A. crucians* is practically ruled out on account of its extreme rarity. It remains, therefore, to ascertain what is the status of *A. punctipennis* in the malaria problem. This is much the commonest species of the genus in New Jersey, and in some localities is almost the only *Anopheles.* As it is found practically everywhere in the Eastern United States, it is a matter of hygienic, as well as of scientific, moment to find out whether it is capable of transmitting malaria. The only road to exact knowledge is experiment, and this is sure to be a path beset with difficulties. In fact, it is only by a concurrence of fortunate circumstances that such an experiment can succeed. Usually several

* Dr. Johnson's statements and conclusions concerning mosquitoes are his own, and the conclusions are not necessarily identical with my own in all particulars.

attempts must be made before every condition is fulfilled. It is not surprising, therefore, that for the past season there is only a record of failure. The summer was exceptionally healthy, even in localities usually malarial. Very few cases of malaria were reported by the physicians who are co-operating in the experiment. Owing to continued unsuccess in New Jersey, in the early part of September I requested Dr. Wm. N. Berkeley to attempt it in New York with mosquitoes of my rearing, and he kindly consented. Although he had access to patients at the Bellevue and Presbyterian Hospitals, even there no opportunity offered. Never before had there been so few cases of malaria. Thus the experiment was completely balked.

It is a pleasure to express my sincere thanks to the Harrison Board of Health for the use of one of their rooms as a laboratory; to Mr. John McClure, the house inspector of Harrison, for many favors; to Mr. Horatio N. Parker, the health officer of Montclair, for much friendly assistance; to Dr. R. N. Connolly, bacteriologist to the Newark Board of Health, for many laboratory favors; to Dr. William N. Berkeley, of New York, for generously assisting with the experiment, and to the many physicians of Newark, East Newark, Harrison, Kearny, Montclair and Verona, who took a friendly interest in the investigation.

The Species Met With.

No effort was made to form a comprehensive collection of mosquitoes or to determine how many species inhabit the limited region examined. The species which concern the public are obviously those which are abundant enough to be a menace to health or a source of discomfort. There were encountered but four of this description—*Culex pungens,* the common house mosquito, breeding in a greater variety of localities than any other species; *Culex sollicitans,* the ring-legged or salt marsh mosquito, an almost intolerable pest in and about the meadows, also on verandas and front porches after sundown; *Anopheles punctipennis,* fairly abundant during the latter part of the season, but only seen by me in the free condition as larvæ or pupæ; finally, *Anopheles maculipennis,* not abundant, but of great interest because the only one of our species positively known to be a carrier of malaria.

Mere mention is made of three other species—*Culex territans,* similar to *C. pungens,* but less common and local; *Uranotænia sapphirina,*

a small, rare and very pretty species, twice met with; *Anopheles crucians,* a rare form closely resembling *A. maculipennis,* of which one specimen was reared from the pupa.

As of most interest in the present investigation, study was concentrated on the two species of *Anopheles,* especially upon *A. punctipennis,* some hundreds of which were obtained in the larval state, and scores were reared to adults. *Culex pungens* was also studied, but this was incidental. The species has received a good deal of attention at the hands of American Entomologists, and its near relative in Europe (*C. pipiens*) has also been carefully investigated by Kerschbaumer and others. Most of our knowledge of the life history of the genus *Culex* is based upon these two species. The reasons are obvious—they are both abundant and both are easily reared in confinement. Since the eggs are laid in good-sized bunches, known as "egg-boats," which float on the surface of the water, they are easy to find, and one can start from the egg in rearing experiments.

Of the four recognized and well-established species of *Anopheles* inhabiting the United States, the only one positively known to be a transmitter of malaria is *Anopheles maculipennis* (*A. quadrimaculata,* of many American writers; *A. claviger,* of German and Italian authors). Howard makes the interesting conjecture (1901,* p. 93) that "it is quite within the bounds of possibility that malaria was originally an European disease, and that not only was the disease itself carried from there on sailing vessels, but the mosquitoes which propogate it as well, at least to America."

Since our *Anopheles maculipennis* has been experimentally proven to be capable of serving as the transmitting host of the malarial organism (Berkeley, 1902), it might seem a foregone conclusion that the other species of *Anopheles* are also susceptible. An acquaintance with the life histories of animal parasites, particularly those of the class to which the malarial organism belongs, shows that such reasoning is apt to be fallacious. While highly probable, it is not certain; therefore, each species must be put to the experimental test.

It is a matter of importance from the sanitary standpoint to work out fully and in detail the distribution of *Anopheles* and ascertain to what extent its abundance is correlated with the prevalence of malaria. Judging from the inadequate data available, it would seem

* The year of publication is used as a reference number to the literature-list at the end of the report.

that our two commoner species often replace each other—*punctipennis* being common where *maculipennis* is rare, and *vice versa*. In New Jersey, *punctipennis* is the common species, while *maculipennis* is scarce. In New York City, as I am informed by Dr. Berkeley, *maculipennis* is the prevailing species. During the summer of 1901, Jordan (1902, p. 21) found, at Shelburne, New Hampshire, both *punctipennis* and *maculipennis,* but the latter decidely in the minority. "Only three individuals of *A. maculipennis* were raised from larvæ and pupæ captured during the season, as against thirty individuals of *A. punctipennis* from the same pools." My own experience in collecting adult mosquitoes at the Boston Parental School, West Roxbury, Massachusetts, during October and November, 1901 (Johnson, 1902, p. 213), was that *maculipennis* outnumbered *punctipennis* about ten to one.* It is interesting to note that at Forest Hills, only five miles from the Parental School, *punctipennis* is the prevailing species, while *maculipennis* is comparatively rare. (Theobald Smith, 1901.)

It is, of course, entirely possible that the relative abundance of the two species changes in the same locality from year to year. But neither seasonal nor local preponderance of one species or the other can have much significance until we know whether one species or both are carriers of malaria.

Meteorological Conditions.

Work began July 7th and closed September 17th. During this time the weather exhibited the usual variety of an eastern summer, but without a long "hot spell" and without a drought. The latter half of June had been unusually cool; this probably gave mosquito breeding a setback. Unfortunately, the temperature record is very incomplete. Daily observations were made only during a part of the season, from July 29th to September 16th. The air temperature of the laboratory was taken, also the water temperature in the aquaria. The highest temperature recorded was 30° C. (86° F.), and this but twice—August 4th and 6th. Temperatures between 26° C. (78° F.) and 30° C. were observed on nine days only—July 29th, August 5th, 6th, 8th, 9th, 11th, 18th, 26th, 27th and September 2d. A day temperature of 20° C. (68° F.) or lower was observed at no time during

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* In this case only females were counted, and, by actual count, the number of *A. maculipennis* captured was 248, of *A. punctipennis*, 25.

August and not until September 5th and 6th. When the dishes were in direct sunlight for some time the water temperature was as high as or a degree or two higher than the air temperature; otherwise, a degree or two lower (centigrade).

Breeding Conditions and Localities.

Of the conditions that favor the breeding of mosquitoes, especially *Anopheles*, most important is the aquatic vegetation usually so abundant about the edges of ponds and streams. No matter how large and deep the pond or how swift the stream, such a body of water is dangerous if it has low, weedy banks. No larvæ can live even in a comparatively slow current or in any pond with clean margins and large enough for the wind to raise wavelets, but if vegetation causes "dead water" in a stream or pond the larvæ are protected from wind, waves, currents and often from small fishes that prey upon them. Furthermore, the little bays and segregated pools of all ponds and streams with marshy banks are likely to be prolific breeding places. The particular kind of vegatation seems to make little difference, so long as it does not cut off all sunlight. Vegetation almost or even entirely submerged, like the common water-weed (*Elodia canadensis*), or with floating or slightly-emersed foliage, like pond-lilies and water-cress, or almost wholly above water, like grasses and sedges of moderate height, are alike favorable.

The season's field work has amply borne out these general statements. The banks of the east branch of the Rahway river at Maplewood and at South Orange, where it is a tolerably swift stream, are weedy in places and have little bays and lagoons. All these places harbor larvæ, especially those of *Anopheles*. In Branch Brook park, Newark, no larvæ were found in the large ponds, which have clean, well-kept shores, are free from vegetation and are exposed to the full sweep of the wind; but in the lily ponds, where not only "lilies" (*Nympheaceæ*), but arrow-leaf (*Sagittaria*) and grasses abound, there were numerous larvæ, notwithstanding these ponds are stocked with gold-fish. The grassy borders of the Morris canal are another prolific breeding place. It is well known that this canal extends for many miles through Northern New Jersey. Since it is now fallen into disuse, its banks have grown up to weeds and water plants; thus, it has become a menace to the health of the communities through which it passes.

The rather numerous bodies of standing water in Harrison have not yielded many larvæ, except in very restricted localities. This is due to (1) natural enemies, (2) lemna, (3) tall reeds and cat-tails and (4) the clean margins of most of the ponds.

The extensive flooded area between Fourth street and the Passaic river, bounded north and south by two branches of the Pennsylvania railroad, is stocked with small fishes, abounds with water bugs (especially *Notonecta*) and is partially covered with lemna or duckweed. No larvæ were obtained here. Similar conditions obtain in the flooded meadow between Manor avenue and the Gilbert estate, with the addition of cat-tails and reeds all about the flooded area. In the great meadows to the east and south of Harrison the very dense growth of cat-tails (*Typha augustifolia*) and "reed grass" (*Phragmites communis*), both overtopping a man's head, prevents access of sunshine to the surface water, so it remains cold during the hottest weather. These vast tracts along the lower course of the Hackensack and Passaic rivers are, therefore, not everywhere productive of vast swarms of mosquitoes, as they are popularly supposed to be. It is only in certain localities where the sun has access that they afford prolific breeding places. Such localities are to be found here and there around their borders and in areas where the tall growth has been cut.

In the eastern part of Harrison are several small "kettle hole" ponds and one pond of several acres in extent known as Fairy lake. With the exception of a shallow, temporary pool, densely overgrown with button bushes and very muddy, none of these ponds are favorable breeding places, and in some of them not a single larva was obtained. As to Fairy lake, it seemed to support no animal life whatever. I was informed that so much acid had been discharged into the lake by a neighboring brass work factory as to kill all the fishes. The pond has remarkably clean, gravelly shores and contains little or no vegetation, with the exception of a few spatterdocks (*Nuphar advena*) at one end. Some of the water was brought to the laboratory and *Culex* larvæ placed in it. They lived in it indefinitely; and I am therefore inclined to think that the clean margins and unobstructed surface of the pond have more to do with keeping it free from larvæ than the acid. There are two or three very similar but smaller and uncontaminated ponds in the immediate vicinity, occupying depressions in the glacial drift like the well-known "kettle holes" of Cape Cod and Long Island. These ponds have clean margins, no vegetation, except the

spatterdocks (present in only one), are stocked with small fishes and remain destitute of mosquito larvæ throughout the season.

Conditions most favorable for the breeding of *Culex pungens* are afforded by uncovered cisterns, rain-water barrels and barnyard pools. Such are, fortunately, not numerous in Harrison and Kearny; but two of the sewers discharging to the eastward, into open ditches in the meadows, afford ideal conditions for the breeding of this species. Not that the larvæ occur in the sewer itself or in the ditches—the current is too rapid. Exceptionally high tides back flow the sewage and cause it to overflow the banks of the ditches, where they are too low, and the standing water thus created swarms with the larvæ of *Culex pungens.*

Anopheles was found breeding in abundance in only one place—the ditch in the railway cut of the Erie road, North Arlington. A fine spring furnishes much of the water, the rest of which trickles from the rocky walls. The ditch lacks sufficient fall to carry off the water, and for a long stretch it is chocked with grasses, watercress and *Cyanophyceæ* or blue-green algæ. This latter vegetation evolves so much oxygen it is floated at the surface by the bubbles, and thus furnishes both food and shelter for the surface-dwelling larvæ. These conditions—stagnant ground water, warmed by the sun, abounding in minute algæ and larger vegetation and free of fishes and most insect enemies—are perfect for the breeding of *Anopheles,* which does not appear to thrive in the foul water so favorable for *Culex pungens.* As a matter of fact, *Anopheles* larvæ may occur in waters habitable for any kind of mosquito larvæ; but, so far as the experience of the past season has shown, they are plentiful only in places where such conditions as those above described are fulfilled.

Other breeding localities for *Anopheles* were: (1) Small muck-holes near Manor avenue, Harrison (these dried up about August 1st); (2) flooded grounds on both sides of Manor avenue; (3) pool near Schuyler avenue, Arlington (only in September); (4) weedy margins of Verona lake, also its inlet and outlet; (5) ditch in eastern part of Verona; (6) tributary of east branch of Rahway river at Maplewood.

Natural Checks to the Breeding of Mosquitoes.

These are of two sorts—animal and vegetal. Among the latter is lemna or duckweed. While most forms of aquatic vegetation promote the breeding of mosquitoes, the *Lemnaceæ,* or duckweeds, are unfavor-

able, and in many waters almost or even wholly prevent it. These tiny plants consist merely of a floating frond, resembling a miniature lily pad. It is circular or more frequently lobated and three to six millimeters in diameter. From the under surface hang one or more roots, which never fasten in the soil, but derive their nourishment from the water. Its reproduction, mainly by division of the frond, is so rapid that in a short time (usually before July 1st) it completely mantles quiet waters, notably sheltered ponds and ditches, without perceptible flow. Its extraordinary abundance, often covering whole acres of shallow water, makes it an efficient protection from mosquito breeding. Wherever this plant forms a complete covering no larvæ have been found. Such places should never be treated with oil, for nature has provided a far more lasting and equally effective protection. It is probably impossible for a mosquito to lay her eggs on lemna-covered water. Even should larvæ wander in from adjacent waters, they would be unable to reach the surface for air, and would thus soon become asphyxiated. Larvæ of *Culex pungens*, injected by means of a pipette beneath the lemna in the jar shown in Figure 10, died in less than an hour. Where the lemna mantle is not complete, but presents interspaces of open water, larvæ of both *Culex and Anopheles* will usually be found in small numbers only, for lemna waters are apt to harbor the various predaceous water bugs in great numbers.

Insect Enemies.—Probably all the predatory water bugs and beetles, both in the adult and larval state, prey on mosquito larvæ. These carnivorous insects abound in shallow, permanent bodies of water wherever there is vegetation. It is not surprising, therefore, that such waters should produce far fewer mosquitoes than temporary pools where enemies are absent. Among these predatory insects the water boatmen (*Corisa* and *Notonecta*), the water striders or "skate bugs" (*Hydrobatidæ*) and the water scorpions (*Nepidæ, Belostomatidæ*) deserve mention. My observations were mainly confined to the "water tiger" or larva of the large water bettle (*Dytiscus*). The ability of this voracious creature to clear a pool of larvæ was demonstrated in the laboratory by several captive water tigers, all of them young ones, about a centimeter in length, which created havoc in some of the jars containing *Culex* larvæ.

An outdoor demonstration was afforded by a small pool about half a mile south of the North Arlington railway station, between Schuyler avenue and the meadows. To all appearances this pool, which was barely ten feet across in July and gradually diminished during the

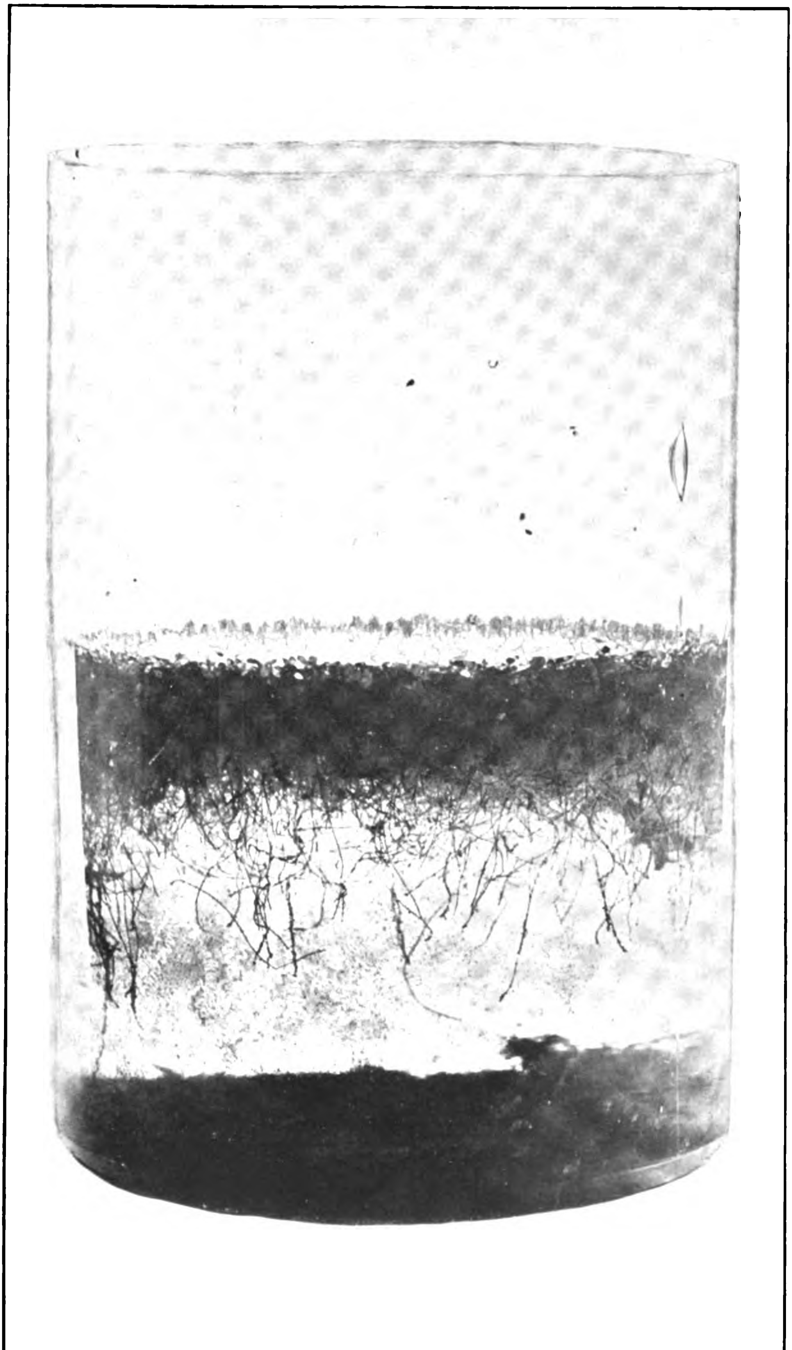

Fig. 10.

A jar of water covered with Duck Weed, showing how the roots extend into the water and bar all access to the surface. From an original photograph.

summer, possessed every condition for the breeding of mosquitoes in great numbers. It contained no fish and few water insects, with the exception of the *Dytiscus* larvæ, which seemed quite abundant. On July 26th, when first visited, the pool was thoroughly examined, but yielded very few larvæ of *Culex* and only two or three of *Anopheles*. The pool was visited again early in August, but no larvæ were found; again August 18th, when a very few *Culex* larvæ were obtained. In order to determine whether the water was incapable of supporting larvæ, ten large and medium-sized *Anopheles* larvæ were placed in a sample of it brought to the laboratory. The next morning there were only eight. The loss of two was accounted for by the presence of a very small water tiger, which had been accidentally left in the jar, and at the moment of discovery had a larva in his jaws. After removal of the enemy, seven of the larvæ completed their development, and all had pupated by the 25th, thus proving that the water was by no means unsuitable for the development of *Anopheles*. The pool was visited again September 6th. Both *Culex* and *Anopheles* larvæ were found in fair abundance, but no *Dytiscus* larvæ were seen. The absence of the voracious water tigers, owing, presumably, to metamorphosis, seems the most plausible explanation of the great increase in the number of mosquitoe larvæ.

Breeding Habits and Development.

I shall confine this division of the subject to a few personal observations. What I have learned this summer is almost entirely limited to *Culex pungens* and *Anopheles punctipennis*. The data have been gathered during only about two months (July 15th to September 15th), and are, consequently, almost wholly in the laboratory, fragmentary and incomplete.

Egg-laying.—Many observers have had, apparently, no difficulty in getting mosquitoes to lay in confinement, but such has not been my experience. In no single instance have they done so, although liberally supplied with water and given every opportunity. Hence, I have no observations to record concerning the laying or the eggs of *Anopheles*, which are hardly to be found in the breeding pools, as they do not cohere to form an egg-boat, but scatter singly over the surface, and thus generally escape detection.

The number of eggs deposited by *Culex pungens* on a limited quantity of water during a season is roughly arrived at by removing the

egg-boats every morning (they are laid only at night or in the early morning), and keeping a record of them. About July 10th an ordinary, wooden waterbucket was placed in a basement window of the Harrison Board of Health office, where mosquitoes had easy access to it through a grating. It was examined every day for a week or so, but no eggs were found; the most probable explanation being that the bucket was new and the water too clean to tempt *Culex* to lay. On August 2d, after an absence of a week on account of illness, and subsequent remissness in examining the water, I found a brood of *Culex pungens* larvæ, about three-quarters-grown, also an egg-boat. The larvæ were all about the same size, and evidently came from a single laying. Some of them were allowed to remain and pupate. The pupæ were all removed August 7th and hatched August 9th.

Eggs were taken at the following dates:

Aug.	2	1 egg-boat.
"	4	5 "
"	5	2 "
"	6	1 "

An iridescent scum appeared on water, and no more eggs were laid until water was changed.

Aug.	14	5 egg-boats.	Bucket placed in yard.
"	15	3 "	

Bucket accidentally upset and water renewed.

Aug.	22	1 egg-boat.
"	31	1 "
Sept.	7	1 "
"	12	1 "
	Total	21 egg-boats.

Adding one laying from which the well-grown brood of August 2d had hatched, gives a total of twenty-two. The nights after September 12th were cold, and no further laying had occurred up to September 17th, when observation ceased.

The weather affects egg-laying. The careful observations of Kerschbaumer (1901, p. 86) are very conclusive on this point. On cold, windy nights few mosquitoes lay their eggs; nor do they lay on rainy nights. Although the record was much interrupted by twice renewing the water, the number of eggs laid on this small quantity of water

between July 15th and September 12th, at the very conservative estimate of 150 eggs per laying, amounts to 3,300 eggs. The chances are that the great majority would have developed to the perfect insect, for food was abundant and enemies none. If 3,000 developed to the perfect insect, then about half, or 1,500, would have been females. These figures are respectfully submitted to the consideration of those who have standing water on their premises.

So far as my observation goes, the eggs of *Culex pungens* almost invariably hatch the night or early morning following that on which they were laid. Howard (1900, p. 23) mentions sixteen hours as the minimum time from egg-laying to hatching. I have noted only one exception to the usual period under ordinary conditions of temperature, and then the eggs hatched on the second morning. It is only necessary, however, to reduce the temperature to delay hatching. A bunch of eggs, found the morning of September 7th, was placed in an ice-chest at 9° C. (48° F.) at 12:30 P. M. the same day, and left there until 4 P. M. the next day. Then they were kept at room temperature, which varied from 20° to 25° C. (68° to 77° F.). They hatched on the morning of September 10th, about seventy-two hours after the time of laying.

Larvæ of Culex pungens.—The newly-hatched larvæ are about one millimeter in length, very transparent, active and have disproportionately large heads. The heart beat is plainly visible. I have timed it when the temperature was 27° C. (84.5° F.) and found it to vary even in the same larva, but to average ninety-four beats per minute.* The observation was made in the region of the thorax.

Kerschbaumer (1901) distinguishes four stages of larval growth: (1) Young larvæ, in which the thorax is still no larger than the head; (2) small larvæ, with thorax somewhat larger than the head; (3) half-grown larvæ, and (4) full-grown larvæ. A molt intervenes between each of these stages. The molt is fragmentary and inconspicuous; no larval "skins" are found in the water until the final molt, when the pupa emerges. At this time the larval skin splits open on the dorsal side of the thorax, and the two breathing tubes of the pupa are thrust out first. At this time the caudal breathing tube of the larva is still apparently in use. With a flop the pupa fairly "jumps out of its skin," and the latter floats away, the breathing tube still adhering to the surface of the water.

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*Average of five counts.

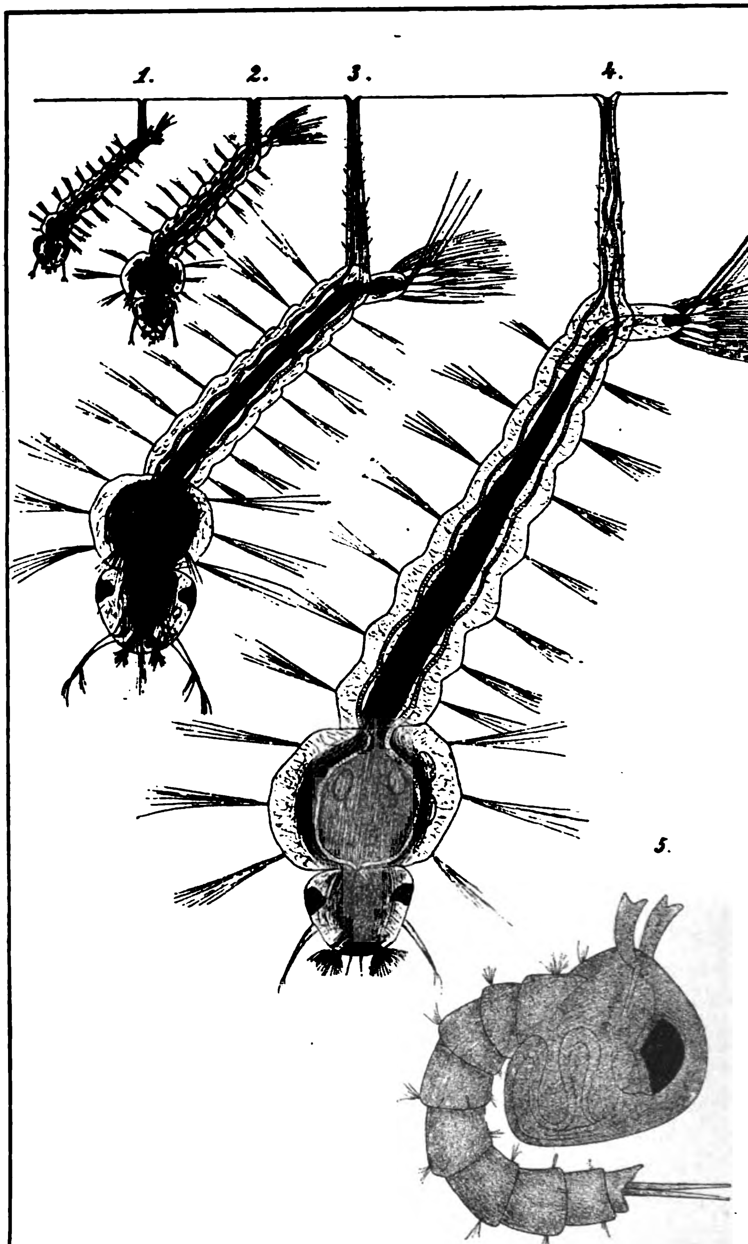

Fig. 11.

Larvæ of *Culex pipiens*: 1, young larva; 2, small larva: 3, half-grown larva; 4, full-grown larva; 5, pupa: all much enlarged. After Kerschbaumer.

Larvæ of Anopheles punctipennis.—The remarks on *A. punctipennis* under this head will no doubt hold good for *A. maculipennis.* It is doubtful whether these two species can be distinguished in the larval and pupal state. The pigmentation on the dorsal surface of the head has been adduced by both Howard (1900, Figure 17, p. 41) and Jordan (1902) as a means of differentiation; but I find it to be exceedingly variable in *A. punctipennis,* like all the coloring of these larvæ, and it only occasionally conforms to the figures published by Howard and Jordan, which, in fact, do not at all agree.

The larvæ of *Anopheles* exhibit the same four stages as those of *Culex.* A molt intervenes between every two. According to Kerschbaumer, the larvæ go to the bottom to molt. I have often observed advanced larvæ lying inert on the bottom, as if dead. They are not then readily stirred into activity. They also go to the bottom to feed, when they have reached an advanced stage of development, as I have observed many times, and as Howard (1901) has already recorded.

The coloration of the larvæ is extremely varied, and is protective. It is often hard to believe this, especially in case of the white and brown, or even white and black ones, which seem so conspicuous; but when the larvæ are amongst the aquatic vegetation, where they naturally live, they are by no means conspicuous. Their colors harmonize with their surroundings. Green larvæ are very common; and in a rich growth of blue-green algæ (*Cyanophyceæ*) I have found blue-green larvæ. Usually the tint is grass-green or brown. Whatever the coloration of the larva, it is transmitted unchanged to the pupa.

Were it not for the fact that *Anopheles* larvæ frequent places abounding with aquatic vegetation, its habitat at the surface of the water would put it at the mercy of every slightest breeze. Ordinarily, it occupies the little spaces between the leaves or stems of the vegetation. When a number are placed in a dish, without such vegetation, it is their habit to fasten to the glass at the water's edge by their caudal bristles, and they often form a row as evenly spaced as a rank of soldiers. No particular side of the dish is preferred; in fact, if there are enough, they may extend all the way round.

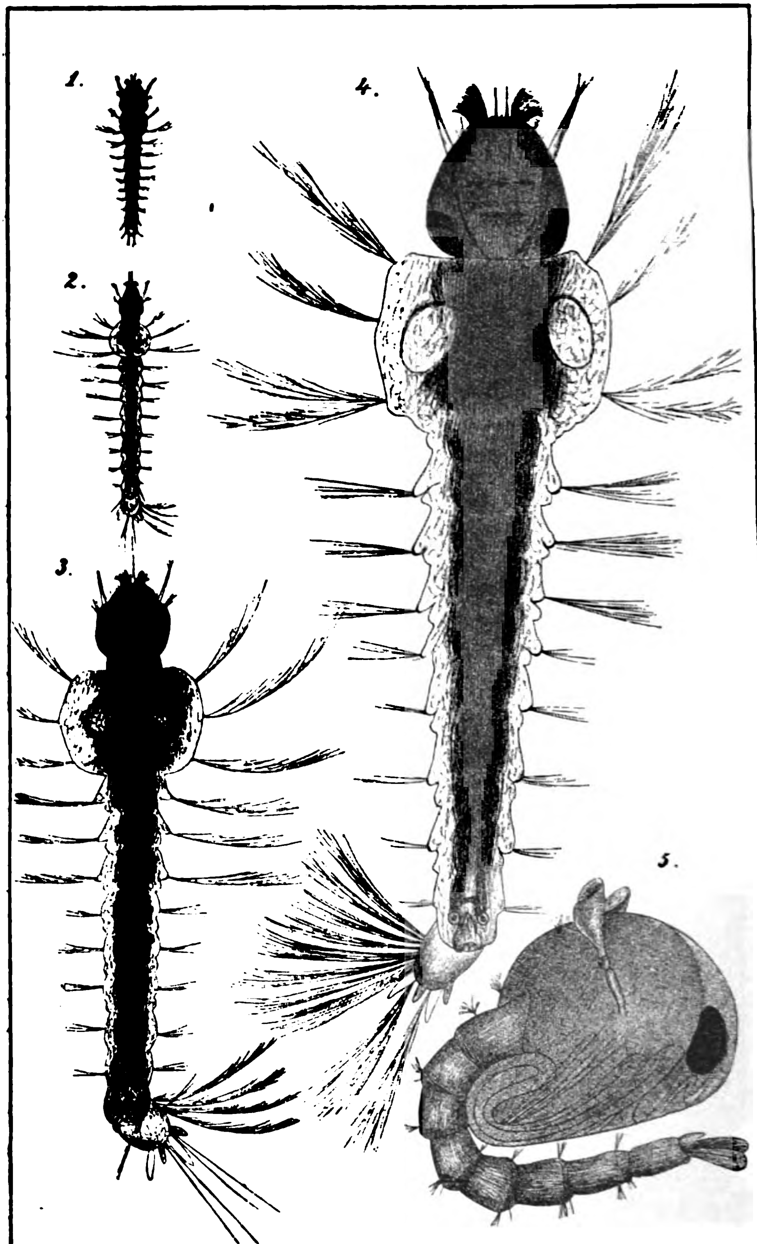

Fig. 12.

Larvæ of *Anopheles maculipennis*: 1, young larva; 2, small larva; 3, half-grown larva; 4, full-grown larva; 5, pupa: enlarged. After Kerschbaumer.

Duration of Larval Life.

This depends upon the conditions of larval existence. The very short period of one week has been reported by Howard (1900, p. 26), but this is possible only in the hottest summer weather and with superabundant nourishment. A fair average, under ordinary conditions, would be about two weeks. Larvæ of *Culex pungens,* reared from the egg in the laboratory and insufficiently nourished during the greater part of their existence, pupated at the end of seventeen days to three weeks, and then at a stage of growth indicated as a half-grown larva in Figure 12. The little pupæ (13 *c*) naturally produced dwarfish adults, and there were twice as many males as females.

The very slow growth of *Anopheles* larvæ under laboratory conditions has been a serious hindrance in rearing them. Usually only the full-grown and nearly full-grown larvæ brought to the laboratory lived to pupate. One-third to one-half-grown larvæ (three to four millimeters long) can be carried through only by constant care. In order to obtain adults in large numbers, it is, therefore, necessary to collect as many advanced larvæ and pupæ as possible.

Duration of Adult Life.

It is often asked, "How long does a mosquito live?"—a question to which a satisfactory answer cannot be given. We know they may and do live a long time under certain conditions. For instance, hibernating mosquitoes live through the winter—even the long Arctic winter. In the tropics they live through the dry season, when breeding is impossible. In captivity they have been known, exceptionally, to live two months; but mosquitoes in confinement are not under normal conditions. It is possible that our summer mosquitoes live longer than the usual lease of life of our captives, which I have found not much to exceed one month for *Culex pungens* and *Anopheles punctipennis.* On the other hand, the usual free life may be briefer. As already stated, my captive mosquitoes have never laid their eggs. It is quite probable the females are not impregnated in captivity, although I have constantly kept males and females together. When an insect has laid its eggs its mission is ended, and it soon dies. If anything prevents or defers egg-laying, then the female may live on. If the males, for any reason, fail to perform their function, they, also, may greatly exceed their usual term of life.

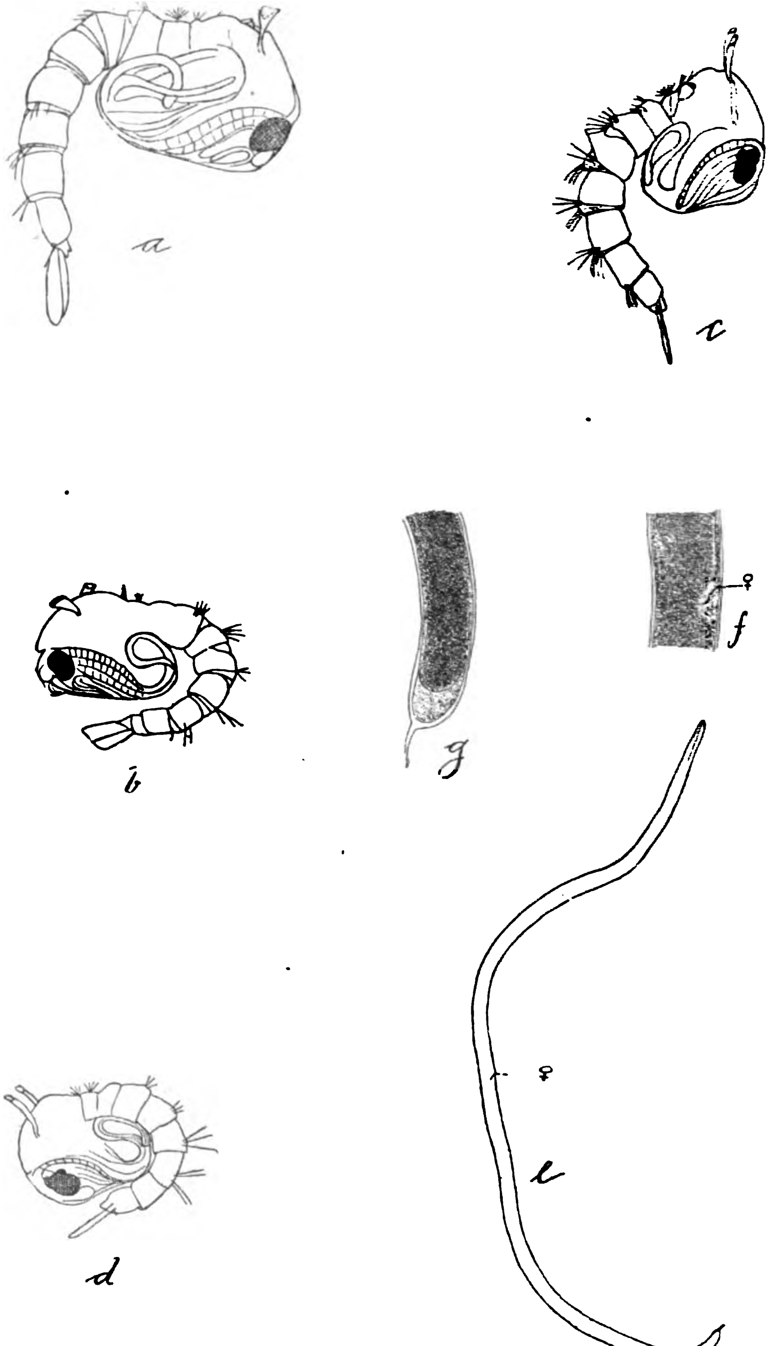

Fig. 18.

All mosquitoes upon which I have based longevity observations have been reared from the larva or pupa. They have been kept in cylindrical, gallon, battery jars. The mouth of the jar is closed with mosquito-bar, held in place by a rubber band. The jar is always kept supplied with water, sometimes also with earth, in which grass or other plants are rooted (although this plan was found objectionable, and was discontinued), and usually with two or three sprigs of "wandering jew" (*Tradescantia*). Ripe fruit, particularly bananas and pears, was used as food, and the female *Anopheles* were allowed to bite at intervals of three or four days. Under these conditions *Culex pungens* have been kept for forty days and *Anopheles punctipennis* for about a month, when the experiment had to be brought to a close. Only a few out of a considerable number have lived so long. The objection may be raised that mosquitoes born so late in the season (August 9th to 19th) may belong to a hibernation brood, which would account alike for their comparatively long life in captivity, and also for their failure to lay eggs. This, however, was not the case, for all, both males and females, fed freely on the fruit, and the female *Anopheles* bit eagerly, even after the middle of September. No conclusions could be drawn from the failure of the later broods of *Culex pungens* to bite, because they had refused to do so throughout the season. Furthermore, a considerable number of females were dissected, and were found to have fully-developed eggs in their ovaries.

Examination of considerable numbers of *Culex* and *Anopheles* from the Boston Parental School, during October and November, 1901, revealed only empty stomachs and undeveloped ovaries. These mosquitoes were all captured indoors, most of them in sleeping-rooms, where they had had every opportunity to bite. It is evident that they had not come indoors to get a meal of blood, but to find hibernation quarters. They were, therefore, the "hibernation brood," which is always the last brood of the season.

The long lease of life of some of the males was a surprise, in view of the reiterated statements of writers to the effect that the males are short lived. A few records are given.

Explanation of Fig. 13.

a, large pupa of *Anopheles punctipennis*, about the maximum size; b, very small pupa of same from an undersized larva; both enlarged 9 diameters; c, unusually large pupa of *Culex pungens*; d, same from an undersized larva reared in the laboratory; both show the small black larval eye adjacent to the large compound eye, and are enlarged 9 diameters. All the above form camera lucida drawings; e, thread worm, parasitic in body cavity of *Anopheles* larva from Delair; ♀ enlarged 12.5 times; f, vaginal region of ♀, enlarged 68 times; g, caudal extremity of same, enlarged 68 times; in figures f and g the small round bodies are ova. Original by H. P. Johnson.

Culex pungens.—Pupæ from waterbucket in basement. August 7th, pupæ put in battery-jar, provided with earth, water and living plants:

Aug.	16	4 males, living.
"	26	3 " "
"	28	2 " "
Sept.	2	1 male, 8 females.
"	5	1 "
"	6	No "
"	18	5 females, which were cholroformed, and record closed.

Longest life of a male, twenty-seven days; of females, forty + days. August 9th is taken as date of hatching from the pupa.

Psorophora ciliata.—Received as larvæ from Mr. William P. Seal, Delair. Pupæ put in battery-jar, arranged as for *Culex pungens.*

Aug.	2. (9:30 A. M.)	1 male, just emerging from pupa.
"	4	2 males, 2 females.
"	13	1 male (dying), 2 females.
"	17	2 females.
"	19	1 female.
"	20	Extinct.

Longest life of a male, nine days; longest life of a female, sixteen days.

Anopheles punctipennis.—(First colony).

Aug.	8.	Started with 19 pupæ.
"	9.	(12 M.) 1 female, 5 males.
"	9.	(6 P. M.) 1 female, 7 males.
"	11.	(10:40 A. M.) 4 females, 7 males.
"	12.	Two dead males found.
"	14.	4 females and 5 or 6 males still alive.
"	14.	12 pupæ added. Two hatched to-day.
"	22.	Males dying off.
"	25.	3 or 4 males left.
"	25.	8 pupæ added.
"	27.	2 pupæ added.
Sept.	3.	8 females, 2 males (from pupæ added August 25th and 27th).

(Record closed.)

Anopheles punctipennis.—(Second colony).

Aug 13.	Many pupæ placed in battery-jar.			
" 17.	12 pupæ placed in same battery-jar.			
" 18.	12 pupæ still unhatched.			
" 19.	3 pupæ still unhatched.			
" 23.	Several males still alive.			
Sept. 2.	5 males,	8 females.		
" 4.	5	"	8	"
" 8.	3	"	8	"
" 10.	3	"	5	"
" 12.	3	"	4	"
" 13.	3	"	3	"
" 15.	3	"	3	"
" 17.	3	"	2	"

(Record closed.)

The last record is the most remarkable, for the males actually held their own better than the females. The conditions for both sexes were precisely the same, except that the females were allowed to bite at intervals, which the males always refused to do.

Proportion of the Sexes, Apparently Determined by Degrees of Larval Development.

With *Anopheles* it was a matter of practical importance to separate the large pupæ (13 *a*) from the small ones (13 *b*). In order to obtain a stock of large, vigorous females for inoculation experiments, it was necessary to get large pupæ from which to rear them. Most of these were pupæ collected out-of-doors or pupæ from very large, full-grown larvæ recently brought in. Of course, large size presupposes ample food, abundant sunshine and possibly other favorable conditions not always realized indoors. Pupæ coming from larvæ that had been long in the laboratory were generally small.

Both from the scientific and the practical point of view much interest inheres in the determination of sex by the external conditions of life. Nowhere have experiments more clearly shown that the proportion of the sexes may be controlled than among insects. Mrs. Mary Treat, of Vineland, N. J., has recently published (1898) an account of a most interesting series of experiments with the butterfly (*Papilio asterias*). When the caterpillars were underfed a great preponderance of males was obtained, almost, but never entirely, to the

exclusion of females. Landois obtained in the same way similar results with the caterpillars of *Vanessa urticæ.*

My results with mosquitoes, while too scanty to be conclusive, are, perhaps, worth recording.

Twenty-three large pupæ of *A. punctipennis* gave fifteen females and six males. Two pupæ died. Therefore, 71.43 per cent. were females and 28.57 per cent. were males. Twenty-three small pupæ of . *punctipennis* yielded three females (20 per cent.) and twelve males per cent.); eight died either as pupæ or in the act of hatching. re is often a high rate of mortality among the small pupæ.

single experiment was made with *Culex pungens.* Larvæ hatched m the egg on August 4th, and 5th were kept in a dish in the labora- y, without sufficient food, and the first pupa was found August 23d, ch must have come from a larva not more than half-grown. Four re pupæ appeared two days later; and, to stimulate pupation, the væ were now liberally fed. By the 29th about twenty pupæ had eared; these had all been placed in a battery-jar, and yielded lve males (66 2-3 per cent.) and six females (33 1-3 per cent.).

Food of Larvæ.

A good many experiments were made to determine the best food for rearing the larvæ of *Anopheles,* and, incidentally, a few with *Culex pungens.* The conclusion reached from these experiments and from microscopic examination of the contents of the alimentary canals of the larvæ was that the minutest algæ, notably *Protococcus, Scenedesmus, Raphidium, Cosmarium,** and no doubt a variety of other Desmids and Diatoms, form the chief food of the larvæ. Bits of filamentous algæ (Spirogyra, etc.) are also swallowed; but animal food was not detected. The larvæ browse on decaying vegetation, eating off not only minute vegetal growths (Bacteria, etc.) that cover it, but the cellular substance of the leaves and stems as well. Epidermal cells of leaves have been found in the stomachs of larvæ.

A good way to promote the growth of *Culex pungens* larvæ is to put grass in the water. In decaying it promotes the development of bacteria, and, later, of microscopic algæ. It is evident, from the prompt growth of the larvæ, that the rotting grass, stems and leaves, and possibly the bacteria, serve as food. As already noted, larvæ of

* I am indebted to Mr. Horatio N. Parker for the determination of these.

C. pungens thrive in very foul water, even that contaminated by sewage. *Anopheles* larvæ I have never found in such water.

The fact that the great bulk of the contents of the stomachs of both *Anopheles* and *Culex* larvæ is *Protococcus,* indicates this as a staple article of diet. I have not observed much selection of the particles brought to the mouth by the vortex created by the maxillary brushes, and there is nothing to indicate such selection in the contents of the stomach. *Anopheles,* being largely a surface-feeder, draws to its mouth all sorts of floating particles. On dusty days a great deal of inorganic matter falls on the water, and these wholly innutritious particles find their way to the stomach in sufficient numbers to make its contents decidedly "gritty." The view expressed by Howard (1900, p. 38), that the specific gravity of the *Anopheles* larva is materially reduced because it feeds upon floating particles, and therefore "it supports this horizontal position just beneath the surface film with comparative ease, and, in fact, without effort, the tension of the surface film itself being hardly needed to hold it," is not sustained by this observation. The large amount of mineral matter which the *Anopheles* larva occasionally takes in certainly does tend to increase its specific gravity, and yet it remains at the surface without the least effort. I have frequently seen the larvæ feeding at the bottom, and lying there inert, without the slightest visible movement or apparent effort. It is evident, then, that their specific gravity, like that of most animals, is actually greater than that of water, and they remain at the surface in a horizontal position because held there by surface tension. Not merely the cephalic and caudal extremities, as represented by Howard (1900, Figure 14; 1901, Figure 19), break the surface film, but, as a rule, the entire length. The position shown by Howard, with only head and caudal end breaking the surface, is sometimes assumed, but it not usual or typical.

Biting Habits.

These particular "habits" of mosquitoes may be considered to require no remark. Most people would regard them as well known already. Still, there are misconceptions regarding this pernicious practice of the female mosquito.

Males, apparently, never bite. Not that they are averse to blood, for Berkeley (1902, p. 29) has found that they will feed upon it if it is offered to them on a swab. Many times I have tried to induce

male *Anopheles* in confinement to bite, but have never succeeded. Female *Anopheles*, a certain number of days after coming from the pupæ, bite quite freely, even during the daytime, which is contrary to their habits when free. In no instance have I been able to induce *Anopheles* to bite until at least six days after leaving the pupa. During this interval, however, they frequently suck the juice of ripe fruit.

It is commonly believed that a mosquito that has gorged itself will not bite again; but recent experimental studies have exploded this idea. Indeed, the transmission of both malaria and yellow fever depends on their biting at least twice. I find that *Anopheles* that have bit once are, if anything, more likely to bite again. They even bite sometimes as frequently as every other day, when they have not fully digested the previous meal. A female *punctipennis* that was kept isolated bit at 9:30 A. M. September 3d; at 10:50 A. M. September 6th; at 11 A. M. September 8th, and at 10:30 A. M. September 10th. After that she was evidently satisfied, for I could not induce her to bite again.

Why female mosquitoes bite is not certainly known. It is sometimes thought that they need the blood in order to mature their eggs; but it has never been satisfactorily shown that they cannot lay after partaking of a simple diet of the juices of plants. Wherever they swarm in uninhabited regions this must be the case. The fact that both *Anopheles* and *Culex* of the hibernation brood do not partake of blood in the autumn before going into winter quarters (when their ova are to remain undeveloped for months), but are most bloodthirsty after they emerge in spring (*Anopheles* at this time, as I have observed, biting even in the daytime), seemingly indicates a correlation between a meal of blood and the rapid maturing of the eggs.

Parasites.

Beautiful clusters of Vorticellids are frequently to be seen on the thorax, abdomen, and even on the head of the larvæ of *Culex pungens*. They may be so abundant as to give the thorax, especially, a whitish, gelatinous appearance to the naked eye. It is unlikely that these Vorticellids do the larva any harm, as the larva simply affords them an attachment and transportation—possibly, food also—brought by the vortex which it creates in the water.

The only internal parasite found was a small Nematode, or thread-worm (Figure 13 *e*), in the larvæ of *Anopheles*. It lives in the body cavity, and is probably not very common. Six were obtained during the summer, all from larvæ sent to me by Mr. William P. Seal, of Delair. Only one was found by dissection, the others were in the bottom of a dish containing a newly-received lot of the larvæ, many of which were dead. The Nematodes were alive, however, and had very likely crawled out of the dead and partly-disintegrated larvæ. The Nematode is about twice as long, on the average, as the larva it inhabits, the specimens represented in Figure 13 *e* measuring 9.17 mm. in length and .16 mm. in greatest diameter, tapering slightly towards anterior and posterior ends. The opening of the vagina (Figure 13 *f*, female) is slightly nearer the head than the posterior extremity. The anus has not been found. The caudal extremity (Figure 13 *g*) is filiform, and tapers to a fine point; its length is not quite equal to the diameter of the posterior region. The entire worm, except a limited region at the posterior extremity, is packed with very minute ova, which completely conceal the intestine. No oral papillæ have been detected.

More abundant material and other stages in its development are necessary to determine the relationships of this interesting parasite. It is possible that it is sometimes numerous enough and sufficiently injurious to serve as a check on the increase of *Anopheles*.

The Transmission of Malaria.

There is a wide-spread misapprehension regarding the way in which malaria is transmitted by mosquitoes. Many who unhesitatingly accept this view are unable to explain upon what foundation it rests, or why it has so quickly won the acceptance of biologists the world over. Many, even of the medical profession, attach little or no importance to the really great differences in the modes of existence of the various disease germs. Hence, it is not surprising that they should regard the malarial organism as a germ of the same sort as bacteria, endowed with the well-known power of most bacteria to live outside the animal body and withstand cold, heat, dryness and other adverse conditions. If this were so, modes of transmission other than that by mosquitoes would require the most careful consideration. No reputable pathologist or bacteriologist would venture to assert that

one might not contract malaria as one contracts typhoid or diphtheria or small-pox. The simpler the life history of a pathogenic organism, the greater the variety of conditions under which it can lead an active existence. As compared with bacteria, the life history of the malarial organism is exceedingly complex; accordingly, we find its conditions of existence rigorously restricted. So far as known, not one of the whole great group of the Sporozoa (literally, spore-producing animals), to which the malaria organism belongs, can lead an active existence outside its appropriate host. Without exception, they are obligatory parasites. Probably all of them pass at least a portion of their cycle within the very cells of their host. It is not surprising, therefore, that none of the Sporozoa have been found to lead a saprophytic existence; that not one has been cultivated outside its host. With the bacteria, on the contrary, it is the exception that they cannot be reared on nutrient media.

The host species of any Sporozoon are always few and closely related; frequently there is but one. Again, within the body of the host these fastidious parasites elect only cells of a certain tissue, and often even that tissue as it occurs in some particular organ. Thus, the entire order Hæmatozoa, to which the malarial organism belongs, live in the red blood corpuscles, but in no other part of the vertebrate body. Here they are completely shut in from the outer world, to which they have no direct access. The blood-sucking habit of the mosquito affords them an exit—first, to the mosquito's body, where they pass through a cycle different from that in the blood, and then, by the agency of the mosquito, back to the circulation of man, beast or bird, according to the special form of malaria.

The Hæmatozoa differ from the rest of the Sporozoa, inasmuch as they live in two hosts, vertebrate and mosquito or some other blood-sucking parasite. In all forms of human malaria yet investigated the carrier host is a mosquito of the genus *Anopheles*. This reveals the highly-specialized nature of their parasitism. *Culex*, so nearly related to *Anopheles*, so like it in all its structure, physiology and habits, cannot become infected, so far as known, with any form of human malaria. On the other hand, the malaria of birds, which differs slightly from human malaria, cannot be transmitted by *Anopheles*, but only by *Culex*. Yellow fever, again, has been experimentally shown to be transmitted by still a third form of mosquito, *Stegomyia fasciata*. For the germ of cattle fever (known in this country as Texas cattle fever) no species of mosquito, nor even any true insect,

serves as the transmitting host, but a blood-sucking parasite of the Arachnid group, the cattle-tick (*Boophilus bovis*) (Smith and Kilborne, 1893). Indeed, there is strong circumstantial evidence that a rare and local human hæmatozoic disease, the "spotted fever" of the Rocky Mountain region, is transmitted by the bite of a tick (Wilson and Chowning, 1902).

Can any species of Sporozoon pass from host to host without an animal carrier? The answer to this question concerns us much. As soon as it is demonstrated that even one form of the disease-producing Sporozoan can pass from one vertebrate to another, we naturally inquire whether this may not be the case sometimes with the malarial parasite also. The answer is, emphatically, no! Notwithstanding there are numerous Sporozoa which pass from one host to enter another of the same species, with an intermediate sojourn in the outer world, this passage is made in the form of encysted spores. Encystment is absolutely necessary to protect these delicate organisms from dessiccation. Since no encystment occurs with the malaria germ, or with any of the known Hæmatozoa, we are justified in concluding that direct transmission is impossible for them. Like the seed of a plant, the animal spore must reach a suitable soil before it can germinate. The only suitable soil is the body of its appropriate host. To give a specific instance: There is a disease of rabbits known as Coccidiosis, caused by the Sporozoon *Coccidium oviforme,* which invades, in vast numbers, the epithelial cells of the gall ducts and small intestine. *Coccidium oviforme* has a life history almost identical with that of the malarial parasite, but with the important difference that both the sexual and asexual cycle are passed in the same host. The rabbit is, so to speak, both the intermediate and the definitive host,* and the Coccidium has simply to pass from rabbit to rabbit. This it does in the most direct way possible, passing out of the body in the form of spores with the fœces, and then, still in the spore form, is taken with the food into the digestive tract of another rabbit, which it infects in turn. Were such a simple mode of direct infection possible for the malarial para-

* The use of the terms 'intermediate" and "definitive" as applied to hosts has heretofore been accurate and clear to parasitology, but unfortunately the mosquito-malaria-theory has introduced some confusion. The definitive host is invariably the one in which the parasite attains sexual maturity, and in which sexual reproduction occurs. All reproductive processes in the intermediate host are asexual. Hence man, not the mosquito, is the intermediate host of the malaria parasite, for the sporulation in the blood is asexual, while the phases in the mosquito are sexual.

site, we may be well assured it would be followed; for nature does not adopt roundabout methods when direct ones will serve her ends. To the parasitologist, therefore, the fact that experiments have shown beyond a doubt that malaria is transmitted by mosquitoes is sufficient proof that this is the only means of transmission.

We may, accordingly, dismiss once and for all the time-honored but never-proven doctrine that malaria germs lurk in damp soil or float in the miasma of swamps, ready to infect mankind whenever the soil is disturbed or the swamp air is breathed. That we may get malaria from swamps and in consequence of breaking the soil cannot be denied; however, we get it, not directly, but because these conditions favor the breeding of *Anopheles*.

Although the life history of the malarial parasite is a subject to which I can add nothing new, and one already much written about, it seems not superfluous, in view of the general failure to comprehend its true import, to state it quite fully, in language as untechnical as is consistent with accuracy.

At the outset it is necessary to define just what is meant by "malaria," for many and diverse ailments masquerade under this convenient guise. Many physicians diagnose as "malaria" a general malaise characterized by a slight fever, which is relieved by administering quinine. Again, there may be a "chill" as well as a fever. Even this does not prove a case of malaria, which can be diagnosed with certainty only from the blood. Unless, after reasonably diligent search, the malarial germ ("plasmodium" or "amœbula") is found in the blood, it is safe to conclude the disease is not true malaria, no matter what the symptoms. The malarial paroxysm or "chill" is undoubtedly the most reliable clinical symptom, but is not infallible.

If freshly-drawn malarious blood is kept at body temperature, and protected from the atmosphere, the plasmodia in the corpuscles may be seen to exhibit active streaming or amœboid movements; hence, the names "Plasmodium" and "Amœbula" are very appropriate. The plasmodium remains constantly within the corpuscle and feeds upon it. The hæmoglobin of the corpuscle is the source of the characteristic pigment seen in the plasmodium. Eventually the corpuscle is destroyed. The application of a suitable dye to a dried blood-smear on a glass slide or cover-glass, stains, not only the plasmodium in its entirety, but also its nucleus, thus demonstrating that the malarial organism is a cell. It is, in fact, a unicellular animal, a protozoon.

By far the commonest type of malaria in this latitude is the tertian, in which the paroxysm comes every other day. The quartan, in which the chill recurs at intervals of seventy-two hours, is comparatively rare; while the æstivo-autumnal, or tropical, fever with us is properly an exotic from the tropics or Southern Europe; but, according to Dr. Berkeley, it has obtained a foothold in New York City, where small epidemics of it occur every summer. In this type of malaria the chills come at irregular intervals.

Parasitologists now recognize that each of these three types of malaria is caused by a different and distinct species of malarial parasite, distinguishable by well-marked morphological characters. Thus, tertian fevers are produced by *Plasmodium vivax;* quartan by *Plasmodium malariæ*, and æstivo-autumnal by *Laverania malariæ.* Some have thought it possible to distinguish a fourth type, the quotidian, characterized by a daily paroxysm. The now generally-accepted explanation of this "type" is that it is simply the result of a double infection of tertian. It is possible, also, to have a double infection of quartan or of tertian and quartan, so that recurrence of the paroxysm may come sometimes every day, or even oftener, and, again, on alternate days.

In every form of malaria the chill marks an important epoch in the life history of the parasite. At this time "sporulation" is taking place—that is to say, the plasmodia, having attained the limit of their individual growth, and having used up all the nourishment afforded by the corpuscle, reproduce asexually. The nucleus divides into several daughter-nuclei, and each of these gathers to itself its due quota of the living substance, the protoplasm, of the mother-cell. The enclosing membrane of the used-up corpuscle now ruptures, and the spores (known technically as the "schizospores" or "merozoits") escape into the blood serum, and thence invade other corpuscles. In doing this they disturb the temperature equilibrium of the body, and the "chill" results. The giving of quinine is most effective at the onset of the chill, because, no doubt, the free spores in the blood are more exposed to the poisoning action of quinine than are the plasmodia in the corpuscles.

If the fever is left to take its course, more and more corpuscles are invaded and destroyed; the patient constantly gets worse. Whether a condition of effective resistance is attainable—in other words, whether we may at length become immune—is not known, because

of the well-nigh universal use of quinine in all civilized countries, thus breaking up the fever before the body has time to develop any resistant powers it may possess. A fact of great significance in connection with this matter is the observation of Koch that the well-known immunity of the Negro race is not natural, but acquired. All Negro children in the malarious regions of Africa have malaria, and as they grow up gradually become immune. Natural immunity among Caucasians is extremely rare; but instances of it have been known in Italy.

The malarial organism was discovered in the human blood by the French army surgeon, Laveran, in 1880. Although his discovery obtained little acceptance for a decade, it has since become universally recognized as the cause of malaria, and has everywhere served as a valuable means of diagnosis. For years the presence of the plasmodium in the blood corpuscle was a standing enigma. It was not difficult to follow it through its apparently simple phases from the spore to the full-grown plasmodium, thence to the spore again. These changes take place with clock-like regularity. But how did the first germs get into the blood, and how can a parasite so located infect new individuals?

Light began to dawn on this knotty problem with the discovery, in 1897, by MacCallum, at Johns Hopkins University, of a new and entirely unexpected phase. Incredible as it may seem, these tiny organisms, unicellular though they are, have a sexual reproduction. The purely asexual, sporulating process in the blood may go on for a long period, but not indefinitely. Sooner or later some of the plasmodia assume an appearance different from the rest. The difference is but slight in tertian and quartan fevers, but in the æstivo-autumnal it is striking. In this form of malaria a large number of the plasmodia assume a semi-lumar form and are known as the "crescents." A general name now applied to these bodies is "gamete" or "gametocyte." On drawing a little blood and closely watching the gametes under the microscope the observation originally made by MacCallum may be repeated. Some of the gametes, distinguishable by slightly larger size, will suddenly be seen to give birth to several actively, lashing, thread-like bodies, known as the flagella or microgametes. These swim actively through the blood serum, and finally unite with other gametes, which have remained inert, producing no flagellated bodies. The union of these two bodies—the inert macrogamete and

the tiny, active microgamete—constitutes the process of fecundation. It is essentially the union of the male element (spermatozoon) and the female element (egg or ovum), which everywhere inaugurates the development of a new being. Only, in the case of the malarial organism, we have to do with a unicellular parasite, and one perfectly adjusted to a very special mode of existence. It was soon ascertained that "exflagellation" (and, consequently, fertilization) never occurs until the blood has been drawn. The cycle which it inaugurates must, therefore, be passed somewhere outside the human body. But where and how?

Two years before MacCallum's discovery an English army surgeon stationed in India, Major Ronald Ross, following a suggestion of Manson, who had then recently discovered that human filariasis is transmitted by mosquitoes, began experimenting with mosquitoes of the genus *Culex*. The mosquitoes were allowed to bite persons suffering with malaria, but with uniformly negative results. The mosquitoes remained sterile. Finally, in 1897, Ross employed "dapple-winged mosquitoes" (*Anopheles*), allowing them to bite a patient whose blood contained the crescents of æstivo-autumnal fever. Four or five days later he found on the stomach of two of the mosquitoes pigmented bodies, evidently parasitic, which he rightly identified as the malarial organism. The matter, however, was not proved. It was not alone necessary that the patient should infect the mosquito; the mosquito, in turn, must infect a human subject. On account of the inevitable difficulties of experimenting with human beings, Ross employed birds, which have their own types of malaria, slightly different from human malaria. The mosquitoes used were of the genus *Culex*—the very species that had given only negative results with human malaria. The experiments were entirely successful. From biting malarious birds the mosquitoes became infected with the malaria. The germs could be followed in their development in the mosquito step by step until the cycle was completed. Then, multiplied ten thousand-fold, in the form of exceedingly minute sickle-shaped bodies (known as "blasts" or "sporozoits"), they gathered in the salivary glands, ready to enter, with the poisonous saliva, the blood of any bird that might be bitten. Healthy birds bitten by mosquitoes having the malaria germs in this stage of development in five to nine days were found to have the plasmodium in their blood.

While Ross was experimenting in India, a number of Italian in-

vestigators, prominent among whom were Grassi, Dionesi, Bignami and Bastianelli, had been busy with the same problem, and the results of their extended and painstaking researches showed, beyond a doubt, that *Anopheles* was the carrier and the intermediate host of the three best-known forms of human malaria, and that *Culex* played the same part for bird malaria. The "mosquito-malaria theory" was now no longer a thought, but an established fact. It only remained to work out details and conduct experiments of a less technical, but more comprehensible and more convenient, sort for those not versed in the intricate life histories of animal parasites.

What manner of development is it that takes place in the mosquito? The figures on Plate 14 (modified from Grassi, 101) will help to make it clear. Starting at 1 with the organism in the form of a sporozoit, which invades the human blood with the help of an infected *Anopheles*, we see, first, the simple, asexual cycle, which produces an attack of malaria. Each of the many sporozoits that *Anopheles* injects, with poison, into the blood seeks a red corpuscle and passes inside of it. It grows at the expense of the corpuscle, becoming the familiar plasmodium, and at full maturity divides into a small number of spores, which are scattered in the blood serum and promptly invade fresh corpuscles. Every time this occurs there is a "chill." At length, gametes appear, at first a few, then numerously. If the patient is now bitten by *Anopheles*, the fertilization (Figure 14, 6) takes place in the mosquito's stomach and the sexual cycle begins. As the first result we get a little, worm-like body, the ookinet or vermicule, which works its way into the wall of the mosquito's stomach. The stage shown in Figure 8 is passed in the wall of the stomach. The subsequent stages, characterized by very rapid growth, occur, apparently, on the outside (*i. e.,* the peritoneal surface) of the stomach, but, actually, just under the extremely thin, muscular and elastic layer, which is very distensible and stretches to accommodate the growth of the parasite. These large bodies soon become visible on the stomach of an infected mosquito (Figure 15,* four and one-half days after infection) with a low power of the microscope. Still, the growth continues (Figure 14, 11), and now we find there has been a division of the nucleus, and the more the amphiont (as it is called) increases in size, the more numerous become the nuclei. Each nucleus gathers to itself a stellate mass of protoplasm.

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* Dr. Berkeley's Figure 49.

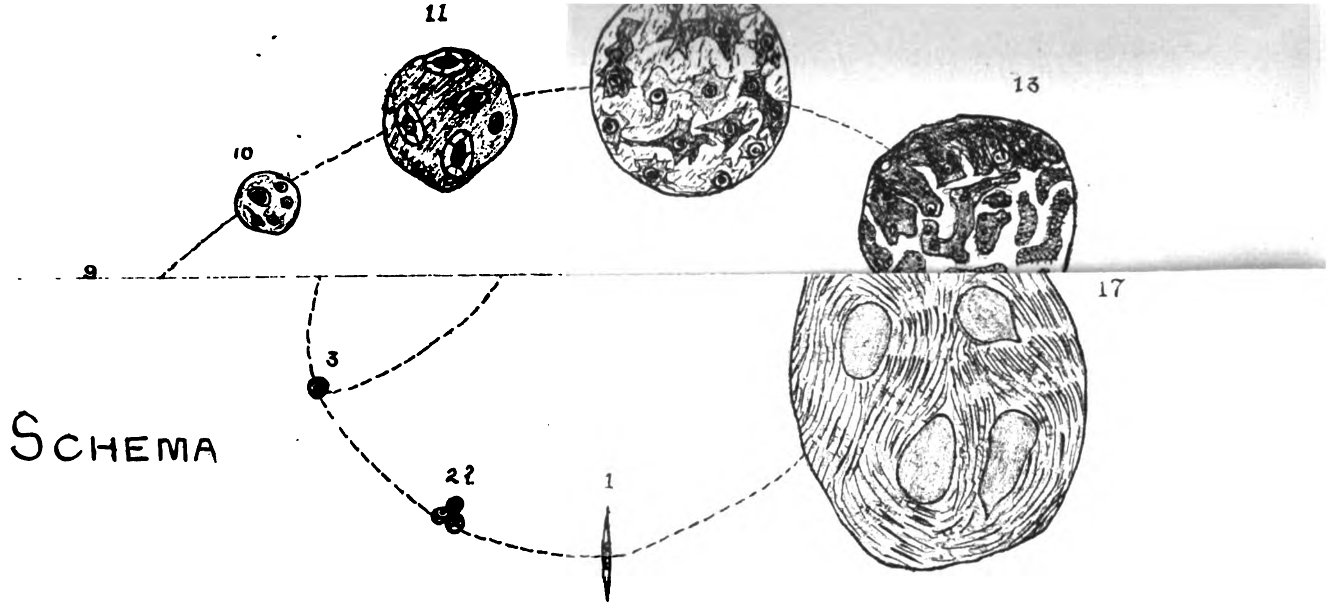

Fig. 14.

Scheme of development for the parasite of æstivo-autumnal malaria. Redrawn from Grassi. *1*, sporozoit introduced into the blood, forming the plasmodium; *2, 3, 4*, which multiplies; *5a*, *I.-VI.*, in the blood itself; *5b*, shows the gametocytes forming the flagellæ; *III.* and *5c*, shows the macrogamete. At *6*, is shown the conjugation of micro with macrogamete, forming through *7* the vermicule at *8*; this forms the amphiont, *9*, *10*, which grows and develops until, at *17*, it is shown filled with sporozoits and ready to burst. Stages shown in figures *1* to *5b*, are passed in the human blood; all others in the mosquito.

Then, within this mass still further divisions of the nucleus take place, the now minute daughter-nuclei crowding to the surface of the irregular masses of protoplasm (Figure 14, 15). Each tiny nucleus is soon the centre of a rod-shaped body, and there are several thousands of these rod-like bodies (the sporozoits) in the enormously-enlarged Amphiont. Large groups of them lie parallel to each other,

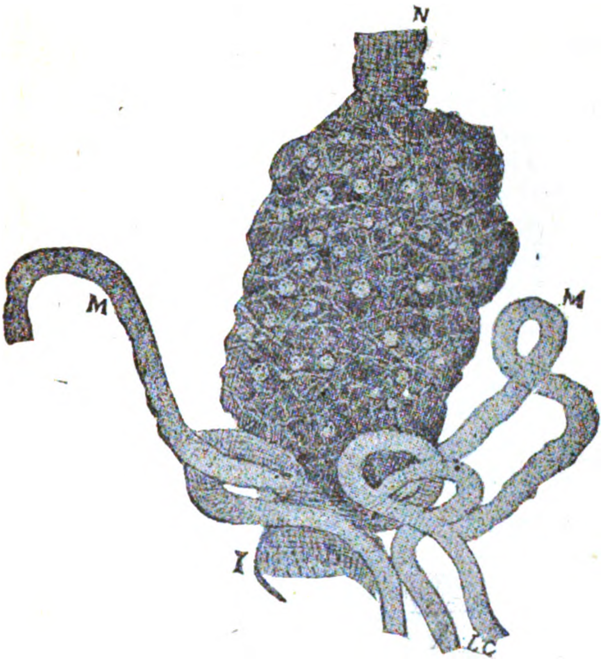

Fig. 15.
Stomach of *Anopheles maculipennis*, showing malarial Zygotes or Amphionts 4½ days old. The rounded, pygmented zygotes lie in the meshes of the muscular fibres. *N*, neck of stomach: *M* malpighian tubules; *I*, ileum. From Berkeley's Lab. Work with Mosquitoes.

producing the characteristic striated appearance (Figure 14, 17). The capsule bursts and the 10,000 or more sporozoits are set free in the mosquito's body cavity. Owing to some attraction of unknown nature, but presumably chemotaxis, they gather in the large, vacuolated cells of the salivary glands (Figure 16). Thence, they are injected, with the secretion, into the first person the *Anopheles* bites, and after a short period of incubation that individual comes down with malaria.

The same mosquito can, and no doubt often does, infect more than one indivudal. The length of time the sporozoits retain their vitality in the mosquito is not known. Observations by Grassi indicate that the sporozoits do not live through the winter in hibernating mosquitoes; and a study of mosquitoes by the writer (see page 575) in the autumn of 1901 would strongly indicate that hibernating *Anopheles* do not bite at all before going into winter quarters. But when

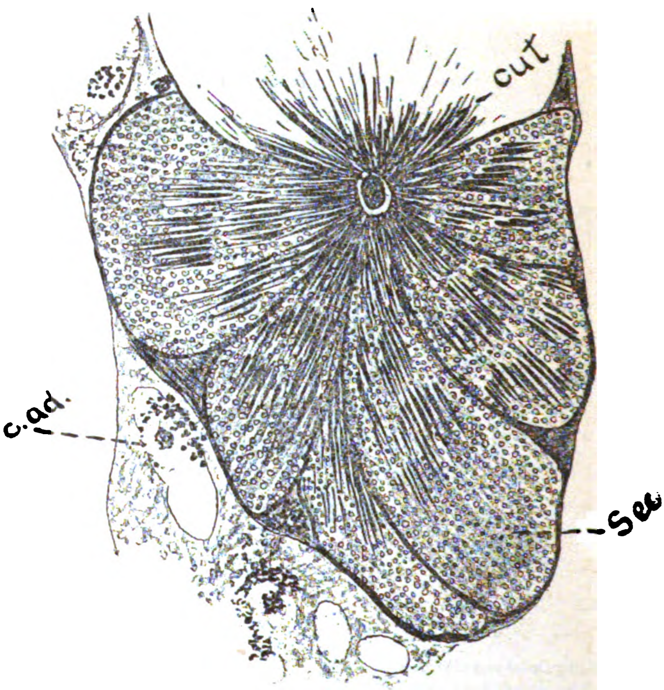

Fig. 16.
Section through a salivary gland of *Anopheles maculipennis*, showing the location of the sporozoits. Redrawn from Grassi.

they emerge in the early spring, such is their eagerness for blood, that they bite even in the daytime.

There is every reason to believe that malaria is carried over from one season to the next in the blood of man, and not in the mosquito. The cases of malaria which develop in winter are relapses of previous attacks; or, in rare instances, an infected *Anopheles* remains active in a warm room and bites at night, thus producing a new case of malaria.

There is good reason to believe that if every case of malaria could be completely cured and all plasmodia eradicated before the advent of another season, endemic malaria in temperate climes would become extinct in a single year.

It has been said on a previous page that the proof afforded by the development of the malarial organism in *Anopheles* and the infection of well persons by infected *Anopheles,* although absolutely convincing to the biologist, is not so to the lay mind. It was necessary that proof of another sort should be obtained, and this was done in a way as interesting as it was convincing.

In the Plain of Capaccio, Italy, Grassi (1901, p. 216), in 1900, made an experiment on a large scale. Ten cottages at the railway station of San Nicolo, Varco and Albanella were made mosquito-proof by carefully screening doors and windows. The doorways were provided with double screen doors. It may be stated, by the way, that the netting was of considerably smaller mesh than customary in this country. Of the 104 persons living in these ten cottages, all but eleven had previously lived in malarious regions; a majority had suffered from it during the previous season. The malarious season began each year about June 13th, according to the testimony of inhabitants of the district. This was confirmed by actual examination of a large number of *Anopheles.* None were found with sporozoits in their salivary (*i. e.,* poison) glands until June 14th. As early as March 25th vigorous efforts were begun to cure all who had malaria in their blood, the result of infection during the previous season. Grassi says: "The spectacle which these people presented before we began our treatment was the saddest imaginable; and those families who had lived in the place during the entire malarial season of the preceding year most strongly excited our sympathy." The "reconstitutions treatment" was not entirely successful, because begun too late. Even in June there were seven relapses of persons who had had malaria the previous season.

During the entire malarial season, from June 25th (when the first new case appeared in that region) till October 15th, the people in the protected houses enjoyed good health, notwithstanding they took no quinine. There were very few cases of sickness other than malaria, and five light cases of malaria, which soon disappeared, and all of which Grassi regarded as relapsing cases.

Of the 415 persons living in the immediate vicinity of the protected houses, every one had malaria during the season.

Another experiment made in the Roman Campagna—a district of most unsavory reputation for its terrible fevers—has been widely published.

In the latter part of the summer of 1900 two London doctors, Sambon and Low, erected a wooden cottage in the Campagna, near Ostia. The place selected was known to be one of the most malarious in the whole Campagna. The house was built so as to leave no chinks or crevices, and windows and doors were thoroughly screened. Drs. Sambon and Low lived here throughout the malaria season. They abstained from quinine, and took no precautions, except to be invariably within doors at sunset and not to go out until daylight. During the day they investigated the cases of human and cattle malaria in the neighboring villages and indoors conducted laboratory work. In short, they lived as people generally live, but were invariably indoors before the flight time of *Anopheles*. With the rains began the most dangerous part of the season. The natives of the region, having malaria in their systems, were pretty sure to come down with an attack at this time. The experimenters frequently went out in the rain and were wet through; but neither of them contracted malaria. The idea has everywhere prevailed that the night air is dangerous; but the well-screened windows of the cottage were left open night and day.

The objection may be made that *Anopheles* occur in many places where there is no malaria. This is perfectly true; but it does not prove that *Anopheles* is not the carrier of the disease. It only proves that the mosquitoes have had no opportunity to infect themselves by biting a malarious patient. A single person with malaria may start an epidemic in any *Anopheles* infested place.

Both from our knowledge of parasites of the class to which the malaria organism belongs and from the abundant experimental evidence we are justified in the conclusion that malaria is transmitted by mosquitoes of the genus *Anopheles*, and in no other way, save by the purely artificial method of inoculation of malarial blood.

LITERATURE CITED.

N. B.—The year of publication is placed first, and serves as a reference number.

1902. Berkeley, Wm. N. Laboratory Work With Mosquitoes. Pediatrics Laboratory, New York; 112 pp. 61 figures.

1901. Grassi, B. Die Malaria. Zweite Auflage. Gustav Fischer, Jena; 250 pp., 8 plates.

1900. Howard, L. O. Notes on the Mosquitoes of the United States. Bulletin No. 23 (new series) United States Department of Agriculture, Division of Entomology; 70 pp., 22 figures.

1901. Howard, L. O. Mosquitoes: How They Live, How They Carry Disease, How They May be Destroyed. McClure & Company, New York; 241 pp., 50 figures.

1902. Johnson, H. P. A New Sporozoan Parasite of *Anopheles*. Journal of Medical Research, VII., 2, pp. 213–219, 1 plate.

1902. Jordan, E. O. Notes on the Occurrence and Habitat of *Anopheles punctipennis* and *Anopheles maculipennis* in the Valley of the Androscoggin. Journal of Medical Research, VII., 1, pp. 1–24, 1 plate.

1901. Kerschbaumer, Fritz. Malaria, ihr Wesen, ihre Entstehung, und ihre Verhutung. Braumuller, Vienna; 170 pp., 12 plates.

1893. Smith, Theobald, and F. L. Kilburne. Journal of Hygiene and Herald of Health, XLVIII., 5, pp.

1902. Wilson, L. B., and Wm. M. Chowning. The So-called "Spotted Fever" of the Rocky Mountains. The Journal of the American Medical Association, July 19th, 1902; 18 pp.